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GARRETT P. SERVISS.
One Who Loved the Stars.

By CLYDE FISHER.

A multitude of readers and admirers were grieved to learn of the passing of Garrett Putman Serviss, student of science from the broad point of view of the all-round naturalist. As a writer he did an immense service to his fellowmen in expounding scientific theories and facts in non-technical language with a style that was both lucid and fascinating. His pen was inspired by imagination, yet governed by accuracy. He loved beauty and truth, and set them forth with the enthusiasm of a born teacher. Both in his writing and his lecturing his favorite subject was astronomy.

Due to an attack of meningitis, following an operation for mastoiditis, Mr. Serviss died in the Englewood (N. J.) Hospital on May 25, 1929, at the age of 78 years. He had made his home in Tenafly, New Jersey, although for a number of years he had spent the summers in France.

Born on March 24, 1851, at Sharon Springs, New York, he was the son of Garrett Putman and Catherine (Shelp) Serviss. His ancestors were pre-revolutionary settlers in the Mohawk Valley, one of his paternal forbears having been killed in the Schenectady massacre in 1690. His great-grandfather, for whom his father and he were named, was Captain Garrett Putman, who served in the Revolutionary War.

He attended the Johnstown Academy at Johnstown, N. Y., and entered Cornell in the course of Science at the opening of the University in the fall of 1868, remained during the four years, and was graduated with "the first through class" in June, 1872, with the B. S. degree.

At Cornell he was a member of the Adelphi Literary Society; a Corporal in the Cadets in his Sophomore, a Sergeant in his Junior, and a Captain in his Senior year. He was Class Poet in his Sophomore year. When officers were chosen for Class Day, he was elected Historian, and his address received special notice in the *Cornell Era*. He was selected by the faculty for a commencement part, and the subject of his oration was, "The Perpetuity of the Heroic Element."

From Cornell he went to New York City with the intention of becoming a lawyer, and entered the Columbia College Law School, then under Professor Theodore W. Dwight. He was graduated LL. B. in June, 1874, and was admitted to the New York State bar the same month.

Instead of practicing law, however, he became interested in journal-

ism, first as a reporter and correspondent on the *New York Tribune,* 1874-1876. He did some work on the *Tribune* that led to an invitation to join the staff of *The Sun,* which he accepted in 1876. Within a couple of years he had become a "copy editor" on that newspaper. At this time he began writing anonymously for the editorial page articles on scientific, principally astronomical, subjects, which Mr. Charles A. Dana frequently had reset in leading editorial type, and placed at the head of his columns, particularly in the midst of some sharp political campaign, as if for an anodyne to over-excited minds. This called the attention of the whole country to the astronomical articles, and the identity of the unknown "Sun's Astronomer" became the subject of speculation in newspaper circles. These articles, on account of their subjects and their treatment, were at that time a novelty, and were widely copied and commented on. The anonymity of their author, however, remained unbroken for years. On account of these articles Mr. Dana advised Mr. Serviss to make astronomy his life work.

His interest in astronomy dates back to his boyhood days when on his father's farm he was attracted by the beauty of the night sky. This interest was greatly stimulated about this time by the gift from an older brother of a small telescope, with which he was able to see the four large moons of Jupiter. As a boy he read extensively on all sorts of subjects, but his predominant interest developed more and more in astronomy.

In 1882 Mr. Serviss became the Night Editor of *The Sun,* a position which he filled for ten years. During this time he continued his editorial articles, and became interested in lecturing on his favorite subjects. At first these lectures were given in places within easy reach of New York, but his success in this field was so marked that he was persuaded in 1892 to resign as Night Editor of *The Sun,* and devote his time principally to the lecture platform. This move was precipitated by an invitation from Mr. Andrew Carnegie to conduct a series of illustrated lectures of a novel kind, which were collectively called "The Urania Lectures." These treated of astronomy, geology, etc., and were illustrated by elaborate stage settings, electric devices, and semi-transparent curtains, whereby realistic and imposing effects were produced, such as landscapes on the moon, solar and lunar eclipses, terrestrial landscapes of past geologic ages with their appropriate plant and animal life, etc. The first was called "A Trip to the Moon." Then came "From Chaos to Man," and finally, "The Wonders of America." The "Urania Lectures" ran until 1894, and Mr. Serviss toured the United States with them with great success. The difficulty in transporting and setting up the elaborate accessories, however, was the reason for giving them up. He continued to give popular lectures on science, travel, and historical and literary subjects. As a lecturer he was much in demand, for he had unusual ability in making his subject clear and fascinating to those who were not specialists in that field. His especial province was popularizing science for the layman, and in this he had rare facility. This,

together with a pleasant voice, a charming personality, and a genuine enthusiasm for his subject, made him a great lecturer.

It is as an author of books and as a writer of newspaper articles that Mr. Serviss is best known. In this way he reached so many more persons, and he gradually devoted more and more time to writing. Through his newspaper articles, which have extended over a period of half a century, and through his articles in the old *Popular Science Monthly* (now the *Science Monthly*), and other magazines, and through his books, it is no exaggeration to state that he has reached a wider reading public than any astronomer who has ever lived.

"Astronomy With An Opera Glass" was his first book, published in 1888, more than forty years ago. This was one of the books used by the writer of this article in getting an introduction to astronomy in Western Ohio in the early eighteen-nineties. Other books on the stars followed, interspersed with several semi-scientific novels: "The Conquest of Mars," (a semi-scientific novel), 1898; "The Moon Metal," (a tale of scientific mystery), 1900; "Realms of the Telescope," 1901; "Other Worlds," 1902; "The Moon," 1907; "Astronomy With the Naked Eye," 1908; "Curiosities of the Sky," 1909; "Round the Year With the Stars," 1910; "A Columbus of Space," (a semi-scientific novel), 1911; "Astronomy in a Nut-Shell," 1912; "The Second Deluge," (a semi-scientific novel), 1912; "Eloquence," 1912; "The Moon Maiden," (a scientific mystery story), 1915; editor-in-chief of Collier's "Library of Popular Science," 16 volumes, 1922; "Einstein's Theory of Relativity," published in connection with the motion picture illustrating that theory. Mr. Serviss aided in editing and captioning the American edition of this wonderful motion picture.

An immense number of newspaper articles, mainly astronomical, has come from his pen, and these have been syndicated all over the United States and Canada. He has been the pioneer in this form of popular education. In the August, 1929, number of *The Monthly Evening Sky Map*, is a beautiful memorial article by the editor, Mr. Leon Barritt, a life-long friend and former colleague of Mr. Serviss. In this he says that Garrett P. Serviss interpreted the abstract phases of science for "the man of the street" in a way that has made his name a household word throughout America. We would like to corroborate this statement, for we believe that Garrett P. Serviss has done more to popularize astronomy than any one in America, and perhaps in the entire world.

As indicated by the name, Mr. Serviss in collaboration with Mr. Leon Barritt invented the "Barritt-Serviss Star and Planet Finder," a most helpful device in use all over the world in schools and summer camps and in the home.

The most sympathetic newspaper account of Mr. Serviss' life and work that has come to my notice, appeared in *The New York Sun*, May 25, 1929, and was written by Mr. James Hickey, who now writes the astronomical editorials and other articles for the newspaper which

published Mr. Serviss' first articles on astronomy. From this I have drawn freely.

Mr. Arthur Brisbane, editor of *The New York Evening Journal,* paid the following fine tribute to his colleague:

"Professor Garrett P. Serviss, who died yesterday, was a noble and a useful man, by his scientific writings known to millions. He turned the thoughts of readers away from this small earth and its petty striving, to the outside universe and its grandeur.

"He had chosen all science for his field of study, but ever returned to astronomy, and possessing the faculty of making abstract truth clear and acceptable to the average mind, he was a most valuable educator.

"He never thought of money, never cared for it, earned just enough to provide for his family and continue his work.

"Professor Serviss' long life of constant industry has added to the knowledge, efficiency and value of many minds. His death means to millions the loss of a valued friend and teacher."

The chief source of information for this article is the biographical sketch in "History of the Class of 1872, Cornell University," published in 1925. Mr. Serviss' step-daughter, Mrs. Marcelle Musso, and his friend, Mr. Leon Barritt, have kindly furnished data.

Mr. Serviss was a Fellow of the American Association for the Advancement of Science, Fellow of the American Geographical Society, member of the American Astronomical Society, member of the Authors' Club, Cornell University Club of New York, and of the University Club of Brooklyn, member of Phi Kappa Phi, Cornell Chapter, former president of the Astronomical Section of the Brooklyn Institute of Arts and Sciences, and honorary member of the Amateur Astronomers Association.

Mr. Service was married twice; first in Ithaca, to Miss Eleanore Betts who died in 1906. Their only son, Garrett Putman, Jr., died while a student at Cornell in 1907. He had won distinction as a mathematical student, and in athletics. Mr. Serviss' second wife was Madame Henriette Gros Gatier of Cote d'Or, France, who still survives. Two step-children also survive, Mrs. Marcelle Musso and Mr. Edward Gatier.

Mr. Serviss traveled widely on the American continent and in Europe, and was an enthusiastic alpinist, wishing, as he said, "to get as far away as possible from the center of terrestrial gravity." In 1894 he surprised and shocked his friends by climbing to the top of the Matterhorn, and in describing that hazardous feat, he wrote:

"I have been asked twenty times if the view from the top of the Matterhorn repays one for the effort expended in climbing it. No, it does not. Some of my friends appear to think that I had an idea of establishing an observatory on the top of the mountain. An observatory would be useless, if placed there. The atmosphere of the Alps is not the kind of air the astronomer is in search of. I had no ulterior

purpose whatever. Do you not know there are some things which are worth doing for their own sake?"

Mr. Serviss was the first honorary member of the Amateur Astronomers Association, and was a frequent attendant at its meetings. On April 3 last, he was scheduled to give his lecture on "The Poetry of Astronomy" before this society, and there was great disappointment when, on account of illness, this lecture could not be given. The following revealing letter, dated April 1, 1929, and addressed to the president of the society, was read to the large audience that had assembled in the auditorium of the American Museum of Natural History to hear the lecture:

"I am dreadfully upset. My daughter has just telephoned you about the doctor's veto on my giving a lecture. I had expected nothing of the kind. I am aware that there is some heart irregularity, but I have paid no attention to it, and would not do so now but for this sudden advice of my old family doctor who says I must go at once to a specialist, and meantime he forbids any tension upon the heart. I am personally confident that I could go through with it all right, but my family has risen in arms! I have been turning the subject of the lecture over in my mind for two weeks, and had prepared what I thought would be no bad thing, and I am dreadfully disappointed, and would kick over the traces and take the bit in my teeth this minute, but for the begging of my wife.

"I am sure you will try to forgive me, but I can hardly forgive myself. My most profound apologies to you, and my grateful thanks for all that you have done—now so badly rewarded. And I feel the disappointment of all my good friends in the Association. I could weep, if I had a little less pride.

Most sincerely yours,
"Garrett P. Serviss."

He continued his writing up to his last illness, which, it will be noted, was not the heart disturbance. He had quite a number of his syndicated articles prepared ahead, so that some of them have been published posthumously.

He had attracted so many grateful admirers and friends, that he must have known that there is a wide-spread feeling that it was good for the people that he had lived. In his passing, the world has lost a real teacher, and a kind, unselfish and lovable man. His influence will live in the hearts of the friends he has left behind, and his books will continue to be an inspiration to coming generations. His popular works on astronomy are a legacy, from one who "loved the stars too fondly to be fearful of the night."

American Museum of Natural History.

ECLIPSE HUNTING IN MALAYA IN 1929.

By HARLAN T. STETSON.

A journey of twenty-five thousand miles for five minutes of astronomical observation seems at best an expensive undertaking. Add to this the uncertainty of favorable meteorological conditions which offer but a fifty-fifty chance to win and you have something of the principal ingredients in the eclipse gamble of the American parties who went to the Orient to observe the total eclipse of the sun of May 9, 1929. Granted that it is clear and one brings home some pictures of the corona, what of it? Excellent pictures of the corona are already in existence. Are a few more plates going to add materially to the world's well-being? Have any startling discoveries been made? Has some new element been found? Has Einstein's theory been proved again or has anything obtained tended to discredit Einstein? These are some of the questions invariably asked of the returned eclipse hunter as soon as he is off the gang-plank. The astronomer knows full well that such questions cannot be met with immediate answers. Indeed they may be entirely irrelevant to the particular program which he has been carrying out. On the other hand he must be patient with the enthusiastic questionings of those who await the reports of eclipse expeditions. He owes the public as well as his colleagues some account of his enterprise, whether successful or otherwise. Most additions to scientific knowledge come from the prolonged study of numbers of observations, and it is through the accumulation of data on eclipses, to which each expedition may add a little, that we may hope ultimately to add to our knowledge of the sun's surroundings.

Believing that in the end something of value is to be derived from standardized measures of the brightness of the corona at different eclipses the Harvard expeditions, at recent eclipses, have been devoted chiefly to photometric investigations. The probable change in brightness of the corona with the changing sun-spot cycle makes it appear especially desirable to obtain data at as many different eclipses as possible in order to ascertain just what effect varying solar activity has on the solar envelope. It is not at all impossible that from some such body of facts some new clue may yet be gained in the problem of sun and earth relations.

With these aims in mind and with apparatus especially adapted to a photometric program our party set sail on the Dollar Steamship liner, *President Wilson,* from San Francisco, on March 22 for the Malay Peninsula. Accompanying me were Mr. and Mrs. Arnold, of New York, and Mr. Josef Johnson, of the California Institute of Technology, at Pasadena. Mr. Arnold, Harvard '18, was formerly Fellow in Astronomy at the Harvard Astronomical Laboratory, and is now

astronomical instructor in the School of Surveying of the American Geographical Society in New York. We were met in the Orient by Mr. P. N. Gray, of New York, who accompanied us on our expedition and subsequently assisted in the photographic part of the expedition, both in the provision of certain pieces of apparatus and in making the exposures. In addition to operating the apparatus taken from Cambridge, we undertook the operation of a special ultra-violet camera, designed and constructed at the Mount Wilson Observatory, for the work of Dr. Edison Petitt.

After considerable correspondence with Professor Stratton, of Cambridge University, England, as to possible sites in the British possessions, I decided on Alor Star, capital of the unfederated Malay state of Kedah, as on the whole the most satisfactory destination for our expedition. Alor Star had the advantages of accessibility, long duration of totality, and perhaps as fair prospects for good weather conditions as any place on the track. We were particularly fortunate in choosing this station from the point of companionship, for it was also the choice of one of the two British expeditions, that from the Greenwich Observatory under the leadership of Mr. Jackson. Here also in the English party were Mrs. Jackson, Mr. Carroll, and Dr. Aston.

As the nearest port for disembarkation was Penang in the Straits Settlements we shipped our instruments thither direct from Boston on February 24, on board the *S.S. President Wilson*, the same ship which we later joined at San Francisco. The voyage across the Pacific was interrupted by a day's stop at Honolulu. It was otherwise uneventful, save for the always interesting phenomenon of dropping the day from the calendar in crossing the 180th meridian. We arrived at Kobe, Japan, on April 11, and made a brief detour to Kyoto where we had hoped to call on Dr. Yamamoto, Director of the Observatory at the University. We learned, however, that the Director had left a few days before our arrival for the eclipse track. We stopped at Shanghai where two days in port gave us opportunity to see a bit of the old and new China. Considerable change had taken place on the water front since our last visit in 1926.

A day's stop in Hong Kong gave opportunity for second impressions of one of the most beautiful sea ports in the world. From Hong Kong we steamed southwesterly to Manila where the *President Wilson* lay for two days. We docked there at 7:00 A.M. on April 23, and were greeted at the pier by Professor Hyde, dean of the College of Engineering at the University of the Philippines. He took us directly to the Manila Hotel where we met Messrs. Waterhouse and Lloyd who were en route for Iloilo, with photographic and spectroscopic equipment. Dean Hyde then took us to the Observatory where was explained to us the important work that is being carried on there under the direction of Father Selga. Father Selga had already left for the eclipse station in the Philippines, but we were received by Father Coronas who took great delight in exhibiting to us some of the extraordinary meteorologi-

cal records in connection with the weather service which has long been carried on at Manila. Perhaps the most striking exhibit which catches the eye of the casual observer is a chart of the record rainfall at Baggio, where, during a typhoon, 42 inches of rain had been registered in 24 hours.

From Manila we sailed directly for Singapore. There Mr. and Mrs. Arnold left us to go by rail to Alor Star, while the remainder of our

FIGURE 1.
THE MULTIPLE CORONAGRAPH OF THE HARVARD EXPEDITION, OPERATED BY H. T. STETSON AND P. N. GRAY.

party continued on the *President Wilson,* disembarking at Penang on May 3. There we were met by Mr. Hamilton, British Police Commissioner of the Province of Kedah, who was commissioned to escort our expedition by motor car and lorrie to Alor Star, some 63 miles north on the Malay peninsula. The expedition arrived without mishap, save for the inconvenience of three or four blow-outs. At Alor Star we were the recipients of the delightful British hospitality. Mr. and Mrs. Arnold and Mr. Johnson stayed at the home of Mr. Hamilton, while

PLATE IX

THE SOLAR CORONA OF MAY 9, 1929,
as photographed with a Wratten F (red) filter through thin clouds at Alor Star, Malaya, by the Harvard Eclipse Expedition.

Mr. and Mrs. Gray and myself had as our hosts Judge and Mrs. Dinsmore. Thanks to the courtesy of Mr. Jackson, who had been on the grounds many weeks before our arrival, we were allowed to set up our camp in the enclosure allotted the British party which was just outside the walls surrounding the residence of the British Advisor for the province of Kedah.

We had barely a week in which to get our instruments set up, but efficient help was immediately at hand. Shelters and the necessary foundations were soon set up and by eclipse day everything was in readiness for the great event. A clock-driven equatorial mounting carried the multiple coronagraph for the direct photography of the corona with red and yellow filters, together with an especially adapted cinemagraphic camera for making a continuous record of the entire eclipse, including the partial phases. The cinemagraphic camera was automatically operated during the total phase by an electric motor driven from a storage battery. On account of the importance of an unprejudiced record of sky conditions during an eclipse, I am strongly impressed with the importance of a cinemagraphic outfit for every eclipse expedition. The instruments on the equatorial mounting were operated by Mr. Gray and myself, with Mrs. Gray assisting.

The ultra-violet camera from Mount Wilson was efficiently operated by Mr. Johnson, who was stationed close by. The quartz lens of this outfit was heavily silvered at Mount Wilson, so that no visible radiation was transmitted. Sunlight was fed to this camera by a coelostat, which ran perfectly throughout the eclipse. Mr. Johnson also operated the King's coronal photometer, taken from Harvard for registering on standardized plates the integrated light of the corona, together with its color index.

At a specially constructed bench, Mr. Arnold operated for us a Macbeth Illuminometer, with Mrs. Arnold acting as recorder. The success with this instrument at the eclipse of 1926 fully justified the continuance of its operation as a convenient and efficient means of quantitatively recording the total sky illumination, not only during totality, but throughout the partial phases of the eclipse. The individual shade glasses, provided with this instrument in its standard form as was used at Sumatra, presented some difficulties in quick manipulation. Through the courtesy of the Leeds, Northrup Company a modified form of the instrument had been constructed for our photometric work at Fargernas, Norway, in 1927. Complete cloudiness at the 1927 eclipse had rendered the illuminometer records on that occasion of little value. We were therefore particularly glad of another opportunity to utilize this newly-adapted instrument on the occasion of the present eclipse.

The weather at Alor Star during the week preceding May 9 gave little promise of even the fifty-fifty chance of clear skies, which had been anticipated. Our stay there was during the intermittent period between the northeast and southwest monsoon; which was accompanied by rather generally unsettled conditions. The morning of the eclipse,

however, dawned reasonably clear, and gave fair prospects for a successful event. During the partial phase the sky thickened and the narrowing crescent was frequently obscured by clouds. A half an hour before totality it appeared that we might get nothing. While darkness was falling with the approach of the moon's shadow, the clouds gradually thinned, and although a thin cirrus was overlying the sun during

FIGURE 2.
THE ILLUMINOMETER OF THE HARVARD EXPEDITION, OPERATED BY MR. AND MRS. ARNOLD.

the total phase, the corona was plainly visible for a solar radius beyond the moon's limb. That the cirrus was thinning somewhat with the progress of the total phase appears evident from the fact that a 30-second exposure during the second minute of totality recorded practically as much of the corona as was obtained for a 60-second exposure during the entire first minute of obscuration. Exposures with a yellow filter showed considerable sky fog, while with the red filter (F) fogging was practically entirely absent. The slight overspreading of the light of the corona on the moon's dark disk, as evident in the accompanying photograph (Plate IX), shows the effect of the diffusion of light due

to the thin cirrus through which the exposure was made. The considerable extent of the corona, however, as recorded on the panchromatic emulsion, through the F filter, gives evidence of a considerable amount of red light in the corona itself, which is a matter of some scientific consequence. It is, of course, to be regretted that a veil of cloud vitiates somewhat the value of the quantitative measures of the coronal light registered on our standardized photographs.

The light curve as obtained with the illuminometer proved to be quite smooth and symmetrical, thus indicating that no rapid changes in sky transparency occurred during the progress of the eclipse. Preliminary deductions from the illuminometer readings give for the total sky brightness at mid-minimum 0.15 foot-candles, a value slightly in excess of that obtained at the Sumatra eclipse in 1926. When we take into consideration the fact that the 1929 eclipse was of considerably longer duration, and therefore on this account more of the inner corona was covered by the moon than in the 1926 event, it appears that the present corona must have been considerably brighter than on the previous occasion, thus distinctly favoring the hypothesis of increased illumination near the maximum of solar activity.

The exposure with the ultra-violet camera was continued for practically the entire time of totality which at Alor Star was 4 minutes and 59 seconds. The plate when developed showed several conspicuous prominences and an image of the inner corona extending for a few minutes of arc away from the sun's limb. As previously announced it was hoped through long exposure photographs of the outer corona to extend photometric investigations to a considerably greater distance than has been done on previous occasions, and by photographing the zodiacal light on succeeding nights to tie together, if possible, the outer coronal illumination with that from the circumsolar cloud of particles which appears to be responsible for the zodiacal illumination. The veil of cloud, however, during totality prevented registering the wider extent of the corona anticipated, and a persistently cloudy western sky following the sunsets at Alor Star made impossible the anticipated photometric photography of the zodiacal light. Considering the rather unfavorable meteorological gamble we should perhaps consider ourselves fortunate to have attained the partial success which the forbidding skies did at length allow.

Our return trip was by way of Suez and the Mediterranean on board the Dollar liner *S.S. Van Buren,* bringing us into New York on the morning of June 25, thus completing a second round the world voyage, this time for five minutes of solar observation.

Special acknowledgment is due the British Government for the many courtesies extended, and especially to the Honorable F. W. Clayton, British Advisor for Kedah, whose solicitation for our technical needs, social entertainment, and personal comfort will long be remembered.

Harvard University Astronomical Laboratory, July, 1929.

SATELLITE *U* OF SATURN.

(Third Paper.)

By WILLIAM H. PICKERING.

Since my last paper on this subject was written Greenwich has published exact data relating to the longitude of Saturn, *M. N.*, 1929, **89**, 260, and I have received further information from Capt. Freeman of the U. S. Naval Observatory. All of this information has been condensed in Table I. The first column contains the mean date of the observations from the two observatories. In many cases there was a difference of only one-tenth of a year, and in such cases the even tenth has always been taken. The second column contains the heliocentric longitudes of Saturn. The third and fourth give the deviations of Saturn from its mean place as obtained at the two observatories reduced to heliocentric longitudes. The fifth and sixth give their means and their deviations. The seventh gives the correction to be applied to Hill's theory, taken from the fourth column of Table III of my first paper entitled "The Orbit of Saturn," POPULAR ASTRONOMY, 1929, **37**, 210. The signs however have been reversed, in order that the corrections may be added instead of subtracted. The eighth column gives the resulting deviations of Saturn from its mean place.

TABLE I.

DEVIATIONS IN HELIOCENTRIC LONGITUDE.

Date	H.L.	Green.	Wash.	Mean	Dev.	Corr.$_1$	Δ_1	Δ_2
1900.5	272°	...	−0″.6	−0″.60	...	+0″.08	−0″.5	
01.6	284	+0″.1	+ .6	+ .35	±0″.25	+ .02	+ .4	
02.6	296	− .2	− .4	− .30	.10	− .02	− .3	
03.6	307	− .3	− .4	− .35	.05	− .08	− .4	
04.6	318	+ .6	− .1	+ .25	.35	− .12	+ .1	
05.8	331	+ .4	.0	+ .20	.20	− .16	.0	
06.7	343	+ .5	− .3	+ .10	.40	− .20	− .1	
07.8	354	+ .9	+ .8	+ .85	.05	− .22	+ .6	
08.8	7	+1.0	+ .6	+ .80	.20	− .24	+ .6	
09.8	20	+1.0	+1.0	+1.00	.00	− .25	+ .8	
10.8	33	+ .8	+1.0	+ .90	.10	− .24	+ .7	
11.9	47	+1.6	...	+1.60	...	− .22	+1.4	
12.9	61	+ .6	− .3	+ .15	.45	− .19	.0	+0″.2
14.0	76	+ .4	− .6	− .10	.50	− .14	− .2	.0
15.0	89	+1.1	− .7	+ .20	.90	− .09	+ .1	+ .3
16.0	103	− .7	− .8	− .75	.05	− .03	− .8	− .4
17.0	117	− .8	− .9	− .85	.05	+ .03	− .8	− .4
18.2	132	−1.3	−1.2	−1.25	.05	+ .09	−1.2	− .8
19.2	146	−1.2	−1.0	−1.10	.10	+ .14	−1.0	− .6
20.2	159	−1.9	−1.2	−1.55	.35	+ .18	−1.4	−1.0
21.3	173	−1.2	−1.5	−1.35	.15	+ .22	−1.1	− .7
22.3	186	−1.8	−1.5	−1.65	.15	+ .24	−1.4	−1.0
23.4	198	−1.8	−1.4	−1.60	.20	+ .25	−1.4	−1.0
24.4	210	−1.8	−1.2	−1.50	.30	+ .24	−1.3	− .9
25.4	222	−1.8	...	−1.80	...	+ .24	−1.6	−1.2
26.4	234	−2.1	−1.5	−1.80	.30	+ .21	−1.6	−1.2
27.4	245	−1.7	−1.6	−1.65	.05	+ .18	−1.5	−1.1
28.4	258	−1.3	−1.3	−1.30	.00	+ .14	−1.2	− .8

In our investigations of this object hitherto, we have relied for our longitudes on the second curve of Figure 1, of the above mentioned paper. We have now reached a point in our investigation, however, where this curve is on altogether too small a scale to be useful, and we shall therefore replot the second and fifth columns of Table III of that paper in Figure 1, but using the second and eighth columns of the present Table I in place of the later observations there described. The ordinates are the observed deviations in longitude. The right hand number in the upper row of abscissas at the top of the curve, 160°, gives the heliocentric longitude of Saturn in the first year that we shall consider, 1861, which year is given in the corresponding place in the upper row at the bottom of the curve. It will be seen by the double row of abscissas that something more than two complete *apparent* revolutions

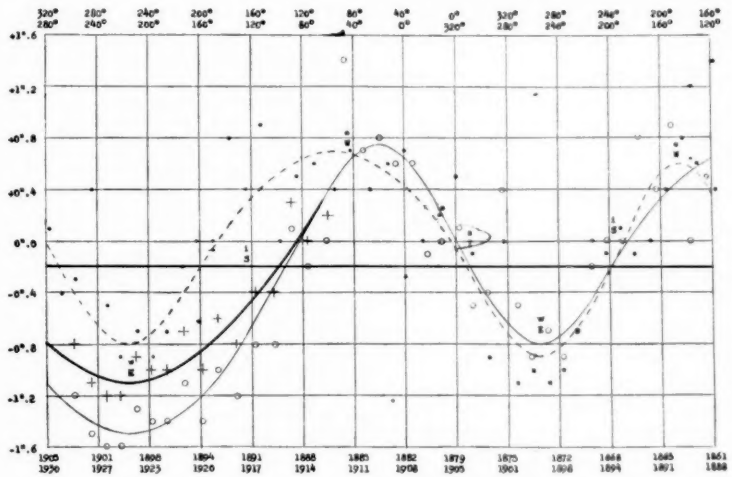


FIGURE 1. DEVIATIONS IN LONGITUDE.

of the satellite are superposed, and that the observations between the dates 1888 and 1905, midway in the series, are plotted in two different places. The observations indicated by the upper row are plotted as dots, and those of the lower row as circles. It will be recalled that the *apparent* revolution of the satellite requires an interval represented by the shift of Saturn through 320° of heliocentric longitude. It is for this reason that the second row of longitudes at the top of the figure is 40° less than the upper row. By plotting the observations with this difference, both the dots and circles can be represented by similar, but as we shall presently see, of necessity not identical curves. The dotted curve represents the dots of the upper line of abscissas, and the fine continuous line the circles of the lower row. It must be remembered that, although these curves appear to represent only a little over two

apparent revolutions, yet owing to our viewing Saturn from a constantly differing standpoint, as fully explained in my first paper, they really represent very nearly five full *real* sidereal revolutions of the satellite, of 13.86 years each.

The small letters at the maximum and minima of the curve indicate that at these points Saturn is farthest to the east and to the west of its mean position. The small letters at the nodes of the sinusoid indicate that Saturn is at inferior and superior conjunction with its satellite. It will be noted that, although the scale of the ordinates is then undetermined, the curve also represents the orbit of the satellite, whose position, however, is precisely opposite to that of Saturn. Its position in its orbit is indicated by the large letters beneath the small ones. The fact that the curves are sometimes sharpest at the bottom, and sometimes at the top, indicates that *U* is moving in an elliptical orbit with a rapid shifting of its major axis. On account of the constant changes occurring in the elements of the orbits of the more remote satellites, and because of the fact that these changes occur far more rapidly than they do in the case of any planet, hundreds or thousands of times, it is from this point of view far more difficult to predict the elements of the orbit of an unknown remote satellite at any given future date, than it is to predict those of a planet. Thus in eight years the eighth satellite of Jupiter changed its period by 8 per cent, and its eccentricity from 0.29 to 0.45. The reason of the greater variability of the orbit of a satellite is that the orbit of a planet is controlled by the Sun, but perturbed by the other planets, while the orbit of a satellite is controlled by a planet, but perturbed by the Sun.

Comparing the fine continuous and the dotted curves in Figure 1, it will be noted at the first glance that they closely resemble one another until the year 1911, and after that the difference is of necessity not in their abscissas, but in their ordinates. The first minimum recorded fell at 295° in 1873, the second at 255° in 1899, and the third at 215° in 1924. The interval in each case is 320°, and the total time elapsed 51 years, or nearly four sidereal revolutions of the satellite. Counting from the minima therefore, or the eastern elongations of the satellite, the period appears to be invariable. This is true also of the interval between the first and second descending nodes, but that between the second and third is very different. Between the two ascending nodes, the inferior conjunctions of the satellite, the interval is 320°. The interval between the three maxima or western elongations is in each case less than the average. A very little consideration indicates the cause of at least a part of the change after 1911, for the very next year Washington changed the form of arrangement of the eyepiece used in its meridian circle, and four years later an analogous change was made at Greenwich, as described in more detail in my first paper. A positive correction of 0″.7 was made in that place for this change for Washington alone, and of 1″.3 for the two observatories when acting together. It now appears that two-thirds of the correction

would have caused a closer coincidence. A careful consideration of the argument given in my former paper would perhaps lead one to believe that this correction was a proper one to make. On the other hand the fine continuous curve as plotted in Figure 1, and which we will designate here for convenience as the "observatory" curve, is the result of the very latest revisions of Greenwich and Washington, each made undoubtedly without any reference to the work of the other, on which the whole theory of my correction was based.

The question may now naturally be asked why should a recent change to a better form of arrangement of the eyepiece cause the planet apparently to reach the meridian 1″.3 later than before? Putting the question in another way, we may ask why should an inferior form of arrangement of the eyepiece formerly employed have caused the planet apparently to transit 0ˢ.087 too early? The constant error assumed is certainly a small one, though very important for our purposes, and is too small for us to attempt any explanation. Of course Saturn looks very different from a star, even with a meridian circle, and so might be differently affected by the change. Certain it is that with the change of eyepiece adopted, the best modern observations in two different years carry the deviation of Saturn from its mean place down to —1″.6 as shown by the curve, while in all previous observations going back as far as 1829, when moderately accurate observations began, the lowest minimum reached was only —1″.1. In support of the observatory curve it may be suggested that, while all of this is very true, yet it is possible that, since the orbit of the satellite is certainly elliptical, it is only in very recent years that the aposaturnium of the satellite has happened to coincide with its eastern elongation. It is because this suggestion appealed to me so strongly that I have used the observatory curve in Figure 1. If we accept it, it almost doubles the assumed mass of the satellite, and changes by many minutes of arc its predicted position in the sky. It is for this latter reason that I am now dealing with this matter at some length. Shall we assume a former constant error of 0ˢ.087, as is certainly indicated by a comparison of the measures made at the two observatories, or shall we not? This question brings out very clearly the fact that locating an unknown planet or satellite in the sky is not a matter of mere computation, but very distinctly also a question of judgment, choice, or opinion. Thus two computers may be equally accurate, yet one of them get a result that is utterly wrong, merely because he chose the wrong alternative. This question also brings out clearly the advantage of the graphical method over the analytical in certain classes of investigation, for while the former may not finally settle the question for us, it at least shows us that there is a question to be settled, while one who used the analytical method of computation might not even know that there was any question to be decided!

Whether we favor the curve that I formerly proposed, or the one designated by the name "observatory," in either case the two curves at elongations 1885 and 1924 are found to have about the same radii of

curvature, and to be much wider than at the other four maxima and minima, those at 1863, 1873, 1899, and 1910. This means that in the case of the two former the satellite was apparently receding from and approaching Saturn more slowly at those times than in the case of the other four. It further indicates that in these two cases the satellite was near aposaturnium, and therefore in general about equidistant from Saturn, and farther from it than at the other elongations. These facts are not well represented by the observatory curve as drawn. Using my former curve the elongation of 1924 was much nearer to Saturn than that of 1885. Using the observatory curve we see that the reverse is the case. The distance of the satellite from Saturn at the elongation of 1885 is the same according to either hypothesis, all the difference occurring in the case of that of 1924. I am therefore inclined to believe that after 1911 a curve lying between the other two would be more accurate than either. In place of my former single correction it is now proposed therefore to make two. In the first place to reduce that correction to one-third of its former value, and in the second while thus raising the observations since 1911 to a less degree than before, to raise all the observations by 0″.2. This last is accomplished most simply by lowering the zero ordinate by this amount, as is shown in the figure by the heavy horizontal line. This is equivalent to assuming that in all the observations considered since 1860, Saturn has appeared to transit the meridian $0^s.013$ later than was really the case. In the last column of Table I the other correction of +0″.2 has accordingly been applied to the figures in the previous column in the first three cases following 1911, where Washington alone had changed its eyepiece. After the analogous change had been made at Greenwich, the correction was changed to +0″.4. These results are plotted as crosses in Figure 1, and a heavy continuous curve drawn through them, which we shall adopt in our future investigations of the orbit of the satellite.

Let us now determine the orbit's eccentricity. All of the curves represented in Figure 1 except that which we have designated as the "observatory" between 1904 and 1915 are symmetrical sinusoids on either side of the zero ordinate. Assuming that the unfinished revised curve between 1915 and 1935 will be so also, we find that the interval between its nodes measured upon ordinate —0″.2 is 230°. The interval between the nodes of 1904 and 1915 is 150°, total length of the curve 380° instead of 320°, the mean value. This is a little longer than we should have expected, but is quite possible, and there is no reason why it should be exactly 320°. Its ratio to the shorter interval 150°, is as 180° to 71°.0. We must remember that these four numbers merely express time, and that the last is proportional to the time taken to reach the node, 90° of arc, from the perisaturnium. It therefore corresponds to the true anomaly, 90° representing the mean. By a table for solving Kepler's problem we at once find the eccentricity of the orbit as projected upon the plane of the ecliptic, to be 0.167. Since the aposaturnium distance taken from the curve is 0″.9, we have the projected semi-major

axis $a = 0''.9/(1+e) = 0''.77$ and the perisaturnium distance $0''.64$. Computing the eccentricity for the maximum of 1886, using either the preceding or following minima, we find that at that time the eccentricity was as high as 0.25, the semi-major axis $0''.72$, and the perisaturnium $0''.54$.

We will now discuss the longitude of the perisaturnium. In Table II the successive columns give the heliocentric longitudes of the elongations, their differences, the corresponding dates, and their differences, the position of the satellite, and its longitude in its orbit around Saturn. The first four columns designate time, the last one arc. The second and fourth columns are obviously not quite proportional, on account of the eccentricity of Saturn's orbit, but the heliocentric longitudes are for many purposes more convenient to use than the dates. It will be noticed by the first and fifth columns that the eastern elongations always differ

TABLE II.

DATES AND LONGITUDES OF THE ELONGATIONS.

H.L.	Diff.	Dates	Diff.	Elong.	Long.
185°		1863.5		W	140°
	110°		9.7		
295		1873.2		E	320
	160		12.8		
95		1886.0		W	140
	160		13.0		
255		1899.0		E	320
	125		10.8		
20		1909.8		W	140
	195		15.0		
215		1924.8		E	320

by 320° of time, as previously remarked, in spite of the differences in the curves. The numbers in the last column are all based on the last superior conjunction of the satellite, when the heliocentric longitude of Saturn was 100° in 1915.8. Based on this figure we conclude that the aposaturnium which occurred in 1923.0 was in longitude 285° as seen from Saturn. On account of the varying period this is uncertain, but is probably the best we can do. Other longitudes in the orbit given later in this paper assume this figure to be correct. The anomalistic period of the satellite, the time of its revolution from perisaturnium to perisaturnium, is necessarily longer than its sidereal period, since the line of apsides advances on the whole. The two widespread elongations of the orbit, those of 1886.0 and 1924.8, occurred 38.8 years apart. Had these been the exact dates of aposaturnium, it would have meant that the anomalistic period of the satellite was this number divided by 1, 2, or 3. Obviously it must be the second, or 19.4 years more or less. Since we see by the last column of Table II that, as seen from Saturn, the longitude of the satellite on these dates was 140° and 320°, that would mean that the perisaturnium itself had in that time travelled through 180°, completing a revolution in 77.6 years. With so rapid a revolution it is not surprising that the anomalistic period should exceed

the sidereal by several years. Indeed by means of this last figure we shall be able to form a fair approximation to the real length of the anomalistic period itself. We find that in 77.6 years the satellite completes 5.60 sidereal revolutions. Since the apsides complete only one, it appears that the time required for the satellite to overtake the perisaturnium is $13.86 \times 5.6/4.6$ or 16.9 years. This is of course an average value, since the period constantly varies.

We can test this figure only when the satellite is near elongation, but by Table II we see that the last elongation occurred in 1924.8. Let us now assume that perisaturnium occurred 1.8 years earlier, in 1923.0. This would be near enough to account for the wide curve with considerable displacement shown in Figure 1. At the previous elongation in 1909.8 the nearest perisaturnium is found 8.5 years prior to 1923.0, or in 1914.5, and the nearest aposaturnium 17 years prior to 1923.0 in 1906.0. Since the elongation lay half-way between them, the curve is not so wide as that of 1924.8, but wider than its predecessor in 1899.0, which we see by the curve coincided fairly well with the perisaturnium at 1897.5 given by subtracting 17 years from 1914.5. It is also noticeable that the displacement indicated by the ordinate is in this case, as it should be, unusually small. The next elongation is the wide and prominent one of 1886.0, which coincides sufficiently well with the aposaturnium of 1889.0. The elongation of 1873.2 lies near the aposaturnium of 1872.0. In this case it is not particularly wide, but is fairly deep, and perhaps should have been drawn deeper still. The earliest elongation, that of 1863.5 lies near a perisaturnium at 1864.0. It is certainly narrow, and its height is somewhat uncertain on account of the scattering character of these early observations. It appears, however, as if these results corroborated the elliptical character of the orbit, indicated in general the longitude of the aposaturnium, and confirmed satisfactorily the anomalistic period of the satellite in 17.0 years. They further confirm us in our opinion that both of the changes in the ordinates adopted in the construction of the revised heavy line of the curve in the figure are justified, notably the universal change of 0″.2.

We will next consider the location of the node of the orbit, as distinguished from that of the sinusoid, and also the inclination of its plane to that of the ecliptic. With regard to the deviations in longitude of Saturn from its mean place as determined at Greenwich and Washington, we have found that they confirm one another satisfactorily, agree closely, and differ on the average by only —0″.21. (See Table I.) The deviations in latitude on the other hand as determined at these two observatories are much less accordant, as we shall now proceed to show. In my second paper on the satellite, entitled "The Orbit of the Undiscovered Satellite *U*," Popular Astronomy, 1929, **37**, 281, we examined the Greenwich deviations, but it so happened that I overlooked those made at Washington, which had been sent to me in manuscript the previous year. We shall now therefore compare them, and shall treat the Greenwich observations somewhat differently from before. The

first three columns of Table III are identical with those of Table I in the above mentioned paper, and following the date give the heliocentric longitude of Saturn, and its deviation in geocentric latitude as determined at Greenwich. The fourth column gives the corresponding heliocentric latitude of the deviation. It was found that these numbers gave an excess *negative* average value of 0″.20. In the fifth column the deviations are corrected by this amount, and the upper curve of Figure 2 is plotted with these numbers as ordinates, and those in the second as abscissas. A sinusoid was then drawn through the observations fitting them as nearly as possible. It will be noticed that these observations

TABLE III.

DEVIATIONS IN HELIOCENTRIC LATITUDE.

Greenwich					Washington				
Year	H.Long.	G.Lat.	H.Lat.	Corr.	Year	H.Long.	Dec.	H.Lat.	Corr.
1901.6	285°	+0″.1	+0″.1	+0″.3	1901.5	284°	+0″.8	+0″.7	+0″.5
02.6	296	+0.1	+0.1	+0.3	02.6	296	+0.2	+0.2	0.0
03.7	308	+0.3	+0.3	+0.5	03.6	307	−0.4	−0.4	−0.5
04.7	319	+0.2	+0.2	+0.4	04.6	318	+0.7	+0.6	+0.4
05.8	330	0.0	0.0	+0.2	05.7	329	+1.3	+0.9	+0.7
06.7	342	+0.4	+0.4	+0.6	06.7	342	+0.9	+0.7	+0.6
07.8	354	+0.3	+0.3	+0.5	07.9	355	+0.9	+0.7	+0.5
08.8	6	−0.3	−0.3	−0.1	08.8	6	+0.8	+0.6	+0.4
09.9	21	0.0	0.0	+0.2	09.8	20	+0.6	+0.5	+0.4
10.9	34	−0.1	−0.1	+0.1	10.8	33	+0.4	+0.4	+0.2
11.9	48	−0.4	−0.4	−0.2	....	..	...	...	...
12.9	61	−0.1	−0.1	+0.1	12.9	61	+0.3	+0.3	+0.1
14.0	76	−0.4	−0.4	−0.2	13.9	75	−0.2	−0.2	−0.3
15.0	89	−0.3	−0.3	−0.1	15.0	89	−0.5	−0.5	−0.7
16.0	103	−1.0	−0.9	−0.7	16.0	103	−0.4	−0.4	−0.6
17.1	117	−0.9	−0.8	−0.6	17.0	116	0.0	0.0	−0.1
18.2	132	−0.5	−0.5	−0.3	18.1	131	−0.1	−0.1	−0.3
19.3	146	−0.7	−0.6	−0.4	19.1	144	+0.4	+0.4	+0.2
20.3	159	−0.1	−0.1	+0.1	20.2	158	+0.4	+0.4	+0.3
21.4	173	−0.5	−0.5	−0.3	21.2	171	+0.5	+0.4	+0.2
22.4	186	−0.4	−0.4	−0.2	22.2	184	+0.9	+0.7	+0.5
23.4	198	−0.6	−0.5	−0.3	23.3	197	+0.2	+0.2	+0.1
24.4	210	−0.5	−0.5	−0.3	24.3	209	+0.8	+0.7	+0.5
25.4	222	−0.1	−0.1	+0.1	....	...	...	...	...
26.5	234	−0.6	−0.5	−0.3	26.3	232	+0.3	+0.3	+0.1
27.5	245	0.0	0.0	+0.2	27.4	244	+0.2	+0.2	+0.1
28.5	258	+0.1	+0.1	+0.3	28.4	256	+0.1	+0.1	−0.1

cover just one wavelength of the sinusoid, thereby justifying the correction of 0″.20. The Washington observations were next treated in the same manner in the last five columns, except that the deviations which were given in declination, and are recorded in the eighth column, had then to be reduced to heliocentric latitudes. It was found that the period of this sinusoid would be 200°. To furnish the proper correction therefore all of the early observations prior to 70° were temporarily discarded, and from the remaining fourteen we deduced an excess *positive* average value of 0″.16, differing thereby by 0″.36 from those of Greenwich,—a rather surprisingly large amount. We can thus hardly say whether on the whole Saturn is located at present to the north or to

the south of Hill's orbit. The results given in the fourth and ninth columns we should expect would strongly resemble one another. In three cases out of twenty-five, all since 1918, their differences equal or exceed a second. The most striking difference between the results however pertains to the latest node, as is shown by the curves in Figure 2, the lower one representing the Washington observations.

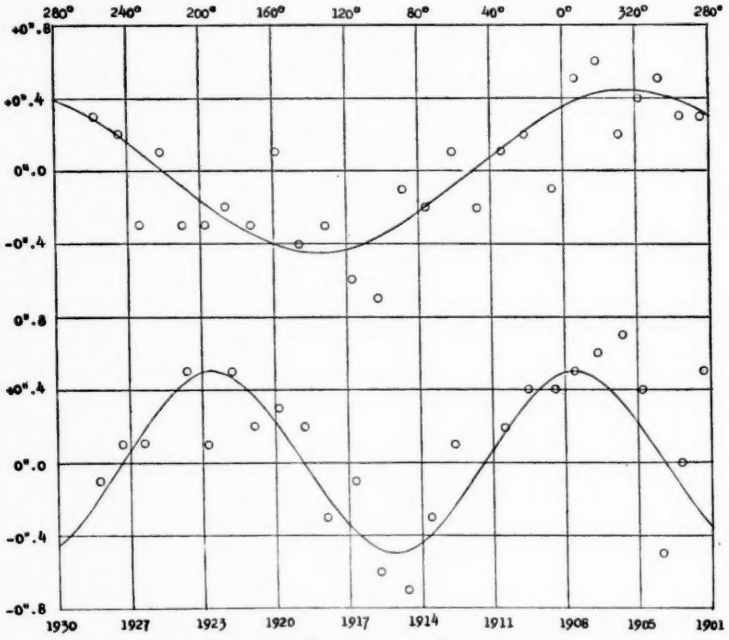


FIGURE 2. DEVIATIONS IN LATITUDE.

The nodical period according to the observations made at Greenwich is 340°, or 26.9 years. The satellite in that time covers its orbit twice. In my previous paper I concluded that these observations indicated a retrograde revolution of the nodes in 38.4 years, and the impossibility of this conclusion did not strike me at once. An examination of the upper curve clearly shows, however, that Saturn was south, and the satellite north of its mean position from 1911 until 1925 or during a whole sidereal revolution about Saturn. Now this is obviously impossible, a satellite cannot describe a small circle in the heavens. It shows either that the curve is wrong, or that the perturbation is not due to a satellite. Indeed the period of the curve agrees sufficiently well with the period of Saturn, and might be interpreted as implying a slight error in the node and inclination of the orbit of that body, and that the satellite itself moved in an orbit but little inclined to that of its primary,

and therefore was not disturbed in latitude. This is certainly a possibility.

On the other hand the Washington observations furnish an utterly different curve, bearing but little resemblance to the upper one. How such a difference between the two series of observations can occur it is impossible to conceive, since both curves are reasonably accordant with the observations secured. According to the lower curve the satellite reached the first ascending node at H.L. 45°, or in 1911.7, and its second one at H.L. 245°, or in 1927.4, difference of H.L. 200°, and of time or nodical period, 15.7 years. Since the nodes generally retrograde, the nodical period is usually shorter than the sidereal. The mean sidereal period as we know is 13.86 years, so here appeared at once a very serious discrepancy. Until the satellite is found, we can only determine its sidereal period by means of its apparent period, which we will recall is a little over 26 years. But the period as we have found varies. By the revised curve in Figure 1 between the last ascending node at 310° in 1903.9, and the coming ascending node at 330° in 1935.3, is 31.4 years, giving a sidereal period between these dates of 15.3 years. The nodical period given above, 15.7 years, agrees with this as nearly as could be expected, considering that the last figure is based on latitudes only, and the former only on longitudes.

Now with regard to the size and shape of the orbit, and the present location of the satellite. In 1924.8 the saturnian distance of the satellite was only two per cent less than that at aposaturnium, and, as we have already seen, Saturn itself, as shown in Figure 1, was at eastern elongation, distance 0″.9. At that date, as we now see by Figure 2, the planet was 0″.4 north of its mean position. Its total distance therefore was 0″.98, and since the semi-major axis as already shown is 77/90 as large, the latter is 0″.84. This would not be quite true except for the fact that on this date the nodes and apsides were nearly at right angles. The corresponding distance of the satellite is given in my first paper as 8224″, and the ratio of its mass to that of Saturn is consequently 1/9770, or practically 1/10,000. We thus at once have a very convenient scale for the orbit of the satellite in Figures 1 and 2. The true eccentricity does not differ materially from that already found. The mass of *U* in terms of Titan is 0.42, in terms of the Earth 0.01, and in terms of the Moon 0.79. Should the satellite prove to be very faint, as it is expected to be, so massive a body must not only be very dark, but its density must be exceptionally high, much higher than that of any terrestrial material. The ascending node in 1927.4 was in longitude 20° as seen from Saturn. In 1924.8 it was in 13°. The aposaturnium in the latter year was in longitude 293°, or 80° less. The satellite was farthest south at H.L. 195° in 1923.1 in longitude 287°. It was consequently at aposaturnium distance and at an angle of 86° from the node. The inclination therefore of the orbit is the angle whose sine is the maximum of the lower curve in Figure 2 divided by the aposaturnium distance 0″.98. From what precedes we find the elements of the

orbit are:

Semi-major axis 137″
Date of last observed aposaturnium 1923.0
Longitude of satellite as then seen from Saturn 285°
Longitude of ☊ in 1927.4 as seen from Saturn 20°
Inclination 31°
Eccentricity 0.17

The apparent period is 26.18 years, and the sidereal period 13.86, or

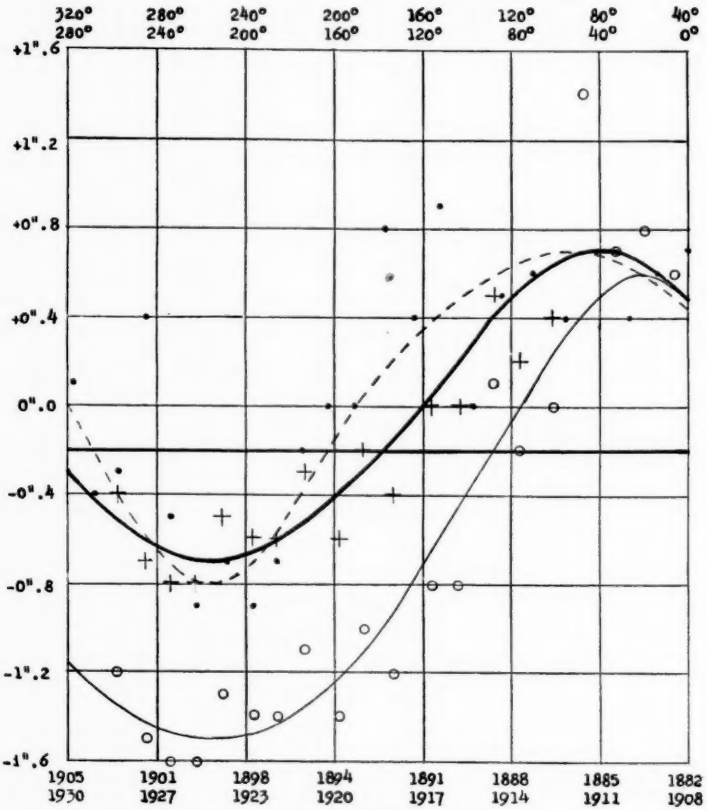


FIGURE 3. GREENWICH LONGITUDES.

5063 days; revolution direct. Instead of locating the satellite by means of the elements of its orbit, however, it is simpler, more direct, and more accurate, to do so by means of the two sinusoids given in Figures 1 and 2. Thus in 1929.5 when Saturn is in longitude 268°, we see by the revised curve that it should be 0″.68 west of its mean position, and 0″.33 to the south of it. Multiplying these numbers by the ratio of their

masses, 10,000, and dividing by 60, U should be found in heliocentric coördinates 113′ east of Saturn and 55′ to the north of it.

If we prefer to accept the latitude curve of Greenwich, and reject that of Washington, the satellite must be moving nearly in the plane of the orbit of Saturn. We shall obtain the most satisfactory curve in this case if we double the corrections to the observations made since 1911, and also change the zero ordinate as before. As a result when we draw the corresponding sinusoidal corrected curve, we shall find that it coincides much more closely with the dotted line than previously. The date of the minimum will be unchanged, but its amplitude will now be reduced from 0″.9 to 0″.5, and the heliocentric longitude of its descending node will be 130°. With this change, the present eccentricity of the orbit will be the same as in 1886, 0.25, its semi-major axis will be 0″.72, and the ratio of its mass to that of Saturn 1/11400. The two curves now agree much better than before, meaning a much smaller change of period. The computed distance of the satellite is 5′ east of Saturn, and it should be found approximately in the same latitude. The whole of the trouble about the longitudes is due to the instrumental changes made at Washington and Greenwich in 1911 and 1915. That they produced an effect on the longitudes is certain, but how large that effect was it is now impossible to determine with accuracy.

With the aid of the curves here given and described, it becomes a very simple matter in case the satellite is not found near its computed position, for the observer to try any other curve in Figures 1 or 3 that may seem to him to be more plausible. If we accept the Washington latitudes, the latitude of the satellite appears to be more certain than its longitude. The reverse is true in the case of Greenwich because of the small size of the latitude perturbation, which we cannot measure, but have called zero. Obviously accepting the Greenwich measures we should search an east and west band passing through Saturn.

If we accept those of Washington, this band should lie 55′ north of the planet. An error of 0″.01 in the location of Saturn on the curves involves an error of 1′.7 in the location of the satellite. Since Saturn is now within 2° of heliocentric longitude 270°, and is gradually getting nearer, any search for the satellite conducted by means of photography can be more conveniently based on heliocentric coördinates than on right ascension and declination. It will be hardly necessary to correct for parallax, since the satellite is only three per cent nearer the Earth than Saturn, but a correction for the distance of the Earth may properly be made.

Private Observatory, Mandeville, Jamaica, B. W. I., July 3, 1929.

AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 329.)

A NEW PHOTO-ELECTRIC PHOTOMETER.

By Joel Stebbins.

The particular feature of the new instrument is the Lindemann electrometer which takes the place of the swinging string electrometer previously used. The photometer performs equally well in all positions of the telescope and is convenient in operation. Stars of photographic magnitude 7.0 may be measured with advantage.

Continued tests strengthen the conclusion that practically all very red stars are variable in light. Of thirty stars of classes M4, M5, and M6, twenty-eight have been found to vary more than a tenth of a magnitude, and the remaining two stars are suspicious.

A favorable case of a spectroscopic binary H.D. 216014, with large range of velocity, is found to be an eclipsing variable with a range of about 0.2 magnitude.

The long-period eclipsing star ϵ Aurigae was found to have reached the minimum in December, 1928. Superimposed upon the main variation is a secondary oscillation of one or two tenths of a magnitude, with an indicated present period of about 120 days.

ON THE PRESENT SUNSPOT MAXIMUM AND A CORRELATION WITH RADIO RECEPTION.

By Harlan T. Stetson and Greenleaf W. Pickard.

Solar investigations in progress at the Laboratory of Astronomy at Harvard University include the daily photography of the sun's surface; the measurement of the coördinates of spots in coöperation with the Mt. Wilson, Yerkes, and Naval Observatories; research on the formation of a better index figure for sunspot activity than the Wolfer Numbers; and nightly measurement of the intensity of radio reception with a study of its variations as a function of sunspot activity.

For the measurement of radio reception we have made use of a superheterodyne receiver with multiple stage amplification together with a self-recording galvanometer of the Cambridge thread type. A local oscillator with controlled output makes possible the exact calibration of the entire receiving circuit prior to each night's observations.

It was found that the hour from nine to ten P.M. was on the whole best suited for determining the index figure for receptivity. The sending station coöperating was WBBM Chicago, which has maintained reliable consistency in the power transmitted and communicated any departures from normal conditions.

That a definite correlation exists between radio reception and sunspot numbers is made evident from the comparison of the curve with that exhibiting the Wolfer Sunspot numbers of the same period.

The character of sunspot groups has led to the theory that the appearance of a double spot presumably of bipolar character has a reduced effect upon atmospheric ionization, whereas the passage of single or widely separated spots may cause an immediate fall of radio receptivity. In such an event it is postulated that the disturbing electrons emitted from a close pair of spots are bound more closely to the solar surface by the interacting lines of forces of a bipolar group and so can less perceptibly effect the ionization of the terrestrial atmosphere. The formation of well-known solar prominences along the lines of force between two closely separated spots is cited in support of this point of view. As fleeing electrons will tend to spiral around the lines of force they will less seldom escape in the direction of the earth where the magnetic field is closed within a relatively short distance on the solar photosphere.

A curve of intensities of signal strength shows the record for the three years, 1926, 1927, 1928, with maxima of reception in July, 1926, and September, 1927. These were dates when sunspot numbers were relatively low. Minima of reception, however, occurred in February, 1926, April, 1927, and July, 1928, which even more noticeably coincide with maxima in the sunspot numbers.

A rather definite fifteen-month period in solar activity as exhibited by both spots and radio reception is an outstanding result of the investigation to date. Each of these sunspot submaxima has indicated increasing solar activity and it does not yet appear possible to state that we have reached the real maximum of the sunspot cycle until the sun peak of 1929 is reached and past. The intensity of that peak will doubtless decide whether or not the true maximum of the present sunspot cycle is reached in 1928 or 1929. Contrary to previous announcements, it may definitely be asserted that the maximum was not reached in 1927.

Another important result of the study of the reception curve is to show how completely unfounded is the popular impression that radio reception is universally poor in summer and good in winter. Generally speaking, reception should be better in the winter months on account of the shortened days and decreased daylight. On the other hand, the sunspot and radio curves of 1926-28 show that the increased solar activity actually gave much poorer reception in the winter months of both 1926 and 1927 than during the summers of the same years. With the recent decrease in spots on the sun, radio reception during the last two months of 1928 has shown considerable improvement. It may be mentioned that the high degree of static due to thunder storms in the summer months results in the fact that the average radio listener will decrease the sensitivity of his set in summer to lessen these disturbances with the necessary accompaniment of low audible intensity of distant

stations. Hence the general impression of a low intensity accompanying warm weather temperature.

In view of the fifteen-month period, we may look for another secondary maximum of solar activity in September or October, 1929.

In conclusion, it seems fair to state that investigations in radio transmission together with researches in the change in the earth's magnetism and electricity and the ultra-violet radiation of the sun may yet prove to furnish the most definite data as to change in solar activity itself.

THE SPECTRUM OF AN ARTIFICIAL PLANET.

By J. Q. Stewart and S. A. Korff.

To the degree that dark lines or bands, in the spectrum of a gas transmitting white light, are due to *scattering,* such lines will fail to appear, or appear bright, in the spectrum of reflected light. On the other hand, if the lines are associated with *absorption* or *fluorescence,* they will appear. In the study of the presence of oxygen and water vapor in the atmospheres of Mars and Venus it tacitly has been assumed that the bands concerned are not produced by scattering. Although probably valid, this assumption will require justification. If invalid, the spectroscopic test for these substances in planetary atmospheres is insensitive.

Production of bright lines where dark would be expected on the idea that all lines are due to absorption is readily illustrated with sodium vapor. An "artificial planet" was made—a cylindrical shell of glass 15 cm long, having an internal diameter of 22 mm, and external diameter, 32 mm. The shell was evacuated; solid sodium was introduced. The "planet" was illuminated approximately uniformly from all directions. The sodium was vaporized by a heating coil. The spectrum in transmitted light showed strong [D] lines. When a reflecting cylinder (of asbestos, glass wool, or silvered glass) was inserted within the inner cylinder of the "planet," the [D] lines in the spectrum in the reflected light were found to exhibit wide bright wings. The sodium vapor was a better reflector than the glass wool, etc., near the [D] lines. Dark cores remained, much diminished in intensity and width. This indicates that scattering is the principal factor at the edges of the [D] lines in this condition; absorption takes place at the centers.

When iodine vapor was substituted for the sodium the dark bands remained unchanged in reflected light. That scattering is insignificant for iodine vapor is indicated by the absence of marked selective refractivity.

The immediate conclusion from this study is that if Venus has a reflecting surface of asbestos, glass wool, or silver, and an atmosphere of iodine vapor, its spectrum in reflected light should indicate the presence of the latter. On the other hand, a slight atmosphere of sodium vapor might escape notice.

A PHOTOMETRIC STUDY OF THE CONTINUOUS SPECTRA OF GIANT AND DWARF STARS.

By N. Wyman Storer.

A method of distinguishing between giant and dwarf stars without an analysis of their spectra is very desirable. Accordingly a search has been made for a difference between the two which might appear as a color-index. Such a search involves a study of the absolute energy curves, and a new method of determining these has been developed.

Spectrograms of 55 stars of all types have been secured at the Lick Observatory. On each plate were also four exposures, of different known intensities, of the spectrum of a comparison lamp.

Since temperature accounts for most of the difference between the spectra of different stars, this must be eliminated in a search for differences between giants and dwarfs. Therefore the temperatures of all stars observed have been determined by comparison of the derived stellar energy curves with Planck curves. They are higher than the best previously accepted values, but a careful analysis of the data has failed to reveal any serious source of systematic error. On the other hand the wide range of spectrum involved, λ4400-λ6900, lends confidence to our temperatures.

Deviations of each stellar curve from its temperature curve have been obtained, and these have been combined into three groups: early type stars, giant stars, and dwarf stars. The last two curves are nearly identical, showing that *no color-index involving only the visual spectrum can distinguish giants from dwarfs.* The suggestion is made, however, that the temperatures of stars might be obtained from color-indices, using spectral regions centering at λ4700 and λ6500, and that such observations together with one in the ultra-violet might distinguish a giant from a dwarf.

SOME RESULTS OF PHOTOGRAPHIC MEASUREMENTS OF THE TRIPLE VISUAL SYSTEM CASTOR A-B-C.

By P. van de Kamp.

On 50 plates, taken between 1915 Oct. 30 and 1928 Dec. 1, the X and Y positions of Castor AB have been measured with respect to 4 stars of average magnitude 9.5. On 13 of these plates the position of Castor C was measured with respect to the same comparison stars. One of the plates was taken as standard plate, and by means of linear plate constants all others were reduced to this one.

A comparison of the measured position angle and distance for the components A and B was made with the ephemerides given by Doberck (*A. N. Jubileumsnummer*, p. 7) and by Rabe (*A. N.*, **216**, p. 74). The differences McCormick — Doberck show little dependence on the time; their means being $\Delta p = -0°.4$; $\Delta d = 0''.00$. The differences McC. — Rabe are fairly constant as far as the position angles are concerned, the

average Δp amounting to —0°.2. But the value of Δd, in the sense McC. — Rabe, increases rapidly with the time. For the plates taken up to 1918 Δd is +0″.06. For the 10 plates taken in 1922-3 Δd is +0″.17, and for the 1927-8 plates Δd amounts to +0″.37. Rabe's orbit, of which the period is 306 years, fails entirely to represent the present distance of the bright Castor components. Doberck's orbit with a period of 477 years represents the present observations well, except for a small difference in position angle.

The parallax of the Castor system is +0″.075. Adopting Doberck's orbit, with a period of 477 years and a semi-major axis of 6″.6, the total mass of Castor AB is found to be 3.4 times the sun's mass. The absolute magnitudes of A and B being +2.2 and +1.4, Eddington's mass-luminosity relation gives masses of 2.5⊙ and 1.6⊙, and a total mass of 4.1⊙, which is in fair agreement with the total mass, just found.

A solution for mass-ratio was made, but the time-interval of thirteen years proved to be too small to separate effectively the motion of the center of gravity of A and B from the orbital motion.

A solution for the relative proper motions of the three components A, B, and C gave:

	A	B	C
rel. $\mu_\alpha \cos\delta$	—″.2079 ± ″.0012	—″.1358 ± ″.0012	—″.1965 ± ″.0017
rel. μ_δ	—.1025 ± .0012	—.0904 ± .0012	—.0777 ± .0017

Adopting Rabe's mass-ratio of 0.42, we find for the proper motion of the center of gravity of A and B:

$$\text{rel. } \mu_\alpha \cos\delta = -0''.1776 \qquad \text{rel. } \mu_\delta = -0''.0974$$

and for the motion of C with respect to the center of gravity of A and B:

$$\text{rel. } \mu_\alpha \cos\delta = -0''.0189 \qquad \text{rel. } \mu_\delta = +0''.0197$$

Thus C has a total motion of about 0″.03 with respect to AB, the direction of this motion differing 26° from the radius vector.

Some 500 double stars, for which physical connection is evident, are being systematically photographed with the 26-inch refractor in order to obtain for one or both components of the system, the positions with respect to some faint surrounding stars. These positions determined at suitable epochs will furnish information about the proper motions of the components, their mass-ratios and possible perturbations in the absolute orbits of the components, etc. For most of the double stars, which are shown to be physically connected by common proper motion only, and which show very small or even no orbital motion, the periods of revolution must be of the order of hundreds of thousands of years. The present-day astronomer will not have the satisfaction even to be able to compute an approximation to the period or mass-ratio of such a double star, but he may have the satisfaction of furnishing an early epoch of position. For the binaries with periods less than a thousand years or so, these photographic observations will give valuable results

in a nearer future. As the telescope is visual, measures of its photographs may be combined with ordinary micrometer measures without fear of systematic errors.

AN INVESTIGATION OF THE PROPER MOTIONS OF FAINT STARS BEING MADE AT THE McCORMICK OBSERVATORY.

By P. van de Kamp and A. Vyssotsky.

This may be considered as a by-product of parallax work and also as an extension and revision of previous investigations by Alden, van de Kamp, and Vyssotsky.

The present program consists of about 250 regions, mostly around Boss stars, for which at least 12 years have elapsed since the early parallax series. From the score of early plates of each region the best plate is selected and used as the early epoch. One recent plate is taken of each region together with an exposure of the north polar sequence impressed upon it. The average best early plates show stars down to visual magnitude $12^{M}.5$. In the average region about 50 stars are measured, the number in the Milky Way being about 150, and at the galactic pole about 20.

Realizing the importance of a knowledge of spectral types, Vyssotsky has used previous plates and has taken special plates at Harvard Observatory for determining spectra of the faint stars in these regions. From the investigations already finished, a total of 5500 spectra has been determined, down to a limiting visual magnitude of about $11^{M}.3$. Spectra are known for about 40 per cent of the stars, or an average of 20 stars per region.

As a first result from this work (which will be completed within 2 or 3 years) there will be determined the absolute motions of some 12,000 stars down to visual magnitude 12.5, with a probable error of about 0″.008 a year. A second result will be a knowledge of the photovisual magnitudes of these stars. Spectra of 5500 stars are already known. Thus, there will be available for discussion extensive material on faint stars, with known magnitudes and proper motions, and partly with known spectra.

In ten regions, which have been completely reduced up to date, 440 stars have been measured, of which number 142, or 32 per cent, have known spectra. This limited number of stars gives a preliminary value

Spectral Division	No.	Mean*	Mean**	Maximum Frequency	Range	Vyssotsky *A. J.* 877
B	2	0″.015	0″.009	....	0″.00 - 0″.03	.....
A	30	.014	.007	0″.01	.00 - .04	0″.006
F	11	.017	.012	.01	.00 - .04	.011
G	32	.042	.039	.04	.00 - .12	.029
K	60	.045	.043	.015	.00 - .41	.020
M	7	.009	.00:	.01	.00 - .02	.014

*Mean Total Proper Motion.
**Mean Total Proper Motion corrected for observational error.

of the average total motion, on the Boss system, of stars down to visual magnitude 11.3 for the six spectral divisions.

54 of the 60 K-stars, or 90 per cent, have a total motion smaller than 0".49; 45 K-stars, or 75 per cent, have a total motion smaller than 0".05. The maximum frequency is at about motion 0".01. The rather high average value of 0".043 is caused by a few stars of large proper motion, most of the motions being very small.

On account of the scantiness of this preliminary material no comparison has been made with other results except with that for average total motion of stars of average visual magnitude 9.3 as measured by Vyssotsky in his Rutherford regions in Cygnus. The agreement is satisfactory. The smaller average values of Vyssotsky's proper motions is probably due to his regions being exclusively confined to the galaxy, which is not the case with the present material.

THE NUMBER OF STARS OF DIFFERENT SPECTRAL CLASSES DOWN TO THE 11TH MAGNITUDE.

By Alexander Vyssotsky.

5484 stars with known spectra have been counted in 236 regions photographed at the McCormick Observatory each covering ⅔ sq. degree and being fairly uniformly distributed north of declination —30°. Spectra were estimated on Harvard photographs, a considerable number of them being taken specially for this purpose with the 24-inch reflector.

Comparison with the tables of Van Rhijn shows that the average limiting magnitude is very near to 11.2, photovisual. Counts were made in the six spectral divisions B0-B5, B8-A3, A5-F3, F5-G0, G5-K3, K5-M9, in three zones: 0-20°, 20-40°, 40-90° galactic latitude, averaging for positive and negative latitudes. The following table gives the number of stars per 100 sq. degrees, the zones being indicated by their approximate average latitudes.

Gal. Zone	B	A	F	G	K	M
10°	209	1303	583	1167	1553	605
30°	18	179	244	910	995	302
60°	3	53	142	666	828	154

In the zone $b = 10°$, 24 per cent of the stars belong to division A; 27 per cent to K; 22 per cent to G. In the zone $b = 30°$ the corresponding figures are: A-stars, 7; K-stars, 38; G-stars, 34. In the zone $b = 60°$ we have: A-stars, 3; K-stars, 45; and G-stars, 36. This shows the predominance of K- and G-stars outside the Milky Way and the high concentration of A-stars in the Milky Way.

Comparison of these results with the discussion by Dr. Shapley and Miss Cannon of the *Henry Draper Catalogue*, and of parts 3 and 4 of the *Draper Extension* shows that the G-stars are relatively much more numerous among the fainter stars, while the proportion of the K-stars in different galactic zones is almost independent of the limiting magni-

tude. The fainter A-stars show a higher galactic concentration and are comparatively less numerous than the brighter A-stars. The following table gives the percentages with respect to the total number of stars down to the limiting magnitude in each galactic zone.

Galactic	——A Stars——			——G Stars——			——K Stars——		
Zone	H.D.C.	D.E.	McC.	H.D.C.	D.E.	McC.	H.D.C.	D.E.	McC.
10°	36.6	34.2	24.0	10.9	14.6	21.5	30.9	24.5	28.6
30°	23.0	12.0	6.7	17.6	24.2	34.4	37.4	36.4	37.6
60°	13.4	6.3	2.9	22.8	30.6	36.0	44.6	44.4	44.9

The galactic concentration in the McCormick regions can be expressed by taking the ratio of the number of stars in the zone 10° to that in the non-galactic zone 60°:

Spectral divisions	B	A	F	G	K	M
Galactic concentration	60	25	4.1	1.8	1.9	3.9

Only one planetary nebula (spectral class Pd) is found among 5,500 stars classified.

It is difficult to make a comparison with the discussion of the first part of the *Draper Extension* where the photographic magnitudes make classes G-M apparently deficient.

The counts in the *Henry Draper Catalogue* and in the McCormick regions give the following average values of the star ratios, that is the factors of the increase of the number of stars with one magnitude added:

Gal. Zone	All	B	A	F	G	K	M
10°	3.0	2.7	2.6	3.3	3.8	2.9	3.4
30°	2.7	2.4	1.8	2.5	3.4	2.7	3.0
60°	2.7	...	1.6	2.4	3.2	2.7	2.7

Thus, the G-stars show the slowest rate of thinning out, and consequently are observed in a comparatively smaller volume of space, a fact already pointed out by Dr. Shapley and Miss Cannon.

THE NEBULOSITY NEAR THE GALACTIC POLE.

By J. G. HAGEN, S. J.

The nebulosity to which attention was called in the May issue of this journal, was examined by Mr. W. S. Franks at Brockhurst Observatory. Under May 9 he writes:

"There is no doubt of the existence of this nebulosity; somewhat patchy to me with the 6-inch refractor, when sweeping. It appeared to extend from about $12^h\ 30^m$ on *p* edge to about $13^h\ 4^m$ on *f*. On the *f* end it came to an abrupt termination near the bright star 41 Comae, where there was a distinct dark gap of clear sky; but at *p* end it seemed to fade away gradually."

The star 41 Comae follows 31 Comae about 5 degrees on the same parallel. Both stars are of 5th mag. The "dark gap," discovered by

Mr. Franks was verified at the Vatican Observatory and will be a great help to observers.

As Mr. Franks is an expert on Herschel's nebulosities (see this journal of October last) and is considered an authority on star-colors (see Harvard Annals XIV p. 93 and Specola Vat. XV) his observation of the Nebulous Cloud at the Galactic Pole should deserve great confidence.

SPECOLA VATICANA, 1929 MAY 20.

COLONEL E. LESTER JONES.

By R. L. FARIS.

The untimely death of Colonel E. Lester Jones, on April 9, 1929, meant a loss to the scientific world of a friend and ally whom it will not be easy to replace. He was, in his own words, an "engineer of men," with a unique ability to encourage and correlate the activities of scientists for the common good.

Colonel Jones had been, for fourteen years, the directing head of the United States Coast and Geodetic Survey and, in that capacity, had used his talent and energy to promote scientific work and investigation. Much of the increased activity and interest in hydrography, geodesy, seismology, and terrestrial magnetism may be traced directly to his influence.

Just as it is not possible to gauge the ultimate value of any single scientific discovery, just so is it out of the question to attempt an immediate appraisal of the importance of any one man's life work in the interests of science. Salient achievements stand out, but only as a striking color note might glow in the interlocking intricacies of a great Gobelin tapestry.

A hint of the monument Colonel Jones builded for himself, however, may be found in the splendid organization whose destinies he guided for fourteen years. The United States Coast and Geodetic Survey, pioneer Government scientific bureau, is today functioning efficiently; it is well organized, well equipped, and making rapid forward strides. For this, the credit must inevitably gravitate toward the man who led, ever encouraged, and efficiently aided its scientific staff.

Colonel Jones was born at East Orange, New Jersey, April 14, 1876. In addition to extended study abroad, he held an A.B. degree and an honorary A.M. degree conferred by Princeton University and was commissioned a hydrographic and geodetic engineer.

In 1913 he was appointed deputy commissioner of the Bureau of Fisheries, holding that position until being appointed the directing head of the United States Coast and Geodetic Survey by President Wilson in 1915.

In addition to his administrative work with this latter bureau, he was

the American member of the International Boundary Commission appointed to fix the boundary between the United States, Alaska, and Canada. He had also been a member of several important Government and scientific missions. One of the last of these was his appointment as a delegate to the International Geographic Congress of 1928, at Cambridge, England.

Colonel Jones was a veteran of the First Army Air Service, A.E.F., and served overseas, for which service he was promoted to the rank of Colonel. He was a member of the Federal Board of Surveys and Maps, the Washington Academy of Sciences, the Explorers' Club of America, the American Society of Civil Engineers, the Washington Society of Engineers, Philosophical Society of Washington, the Cosmos Club, and other organizations, as well as being a life trustee of the National Geographic Society.

A SIMPLE METHOD FOR DETERMINING THE WAVE-LENGTHS OF THE FRAUNHOFER LINES.

By S. A. KORFF.

This note describes an interesting and little known method for making an approximate determination of the wave-lengths of the Fraunhofer lines in the solar spectrum.

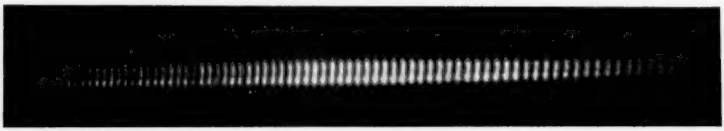
A Michelson interferometer is adjusted for the "white-light" condition, and put in front of a spectroscope, so that sunlight passes through it before coming to the slit of the spectroscope. The normal Fraunhofer spectrum is seen in the spectroscope, and the field is clear of fringes in the "white-light" condition. As the crank on the interferometer screw is slowly turned, interference fringes appear. They are parallel to the Fraunhofer lines, but broader. Near the "white-light" condition they are very broad, and as the interferometer screw is turned away from the condition they become narrower and closer together moving across the spectrum from the red to the violet. Eventually, when the path-difference has become larger, they are so fine as to be no longer distinguishable from the background. Even after several hundred fringes have crossed a given Fraunhofer line, they are broad enough to be quite conspicuous with good resolving power. They present a striking and beautiful appearance.

The theory of these fringes and of the wave-length measurement is simple. If starting from the "white-light condition," where the path difference between the two arms of the interferometer is zero, n is the number of dark fringes which have crossed a given Fraunhofer line, and x is the distance the interferometer mirror has moved, as measured on the slow motion screw micrometer, and λ is the wave-length of the Fraunhofer line in question, then from elementary con-

siderations,

$$x = \lambda\,(n + \tfrac{1}{2}) \qquad (1)$$

The $\lambda/_2$ term enters because we start with the central bright fringe (common to all wave-lengths) and count dark fringes. This term is negligible for the higher values of n.



INTERFERENCE FRINGES AND SPECTRUM LINES.

Photograph showing interference fringes superimposed on Fraunhofer spectrum, giving a natural scale of frequencies, from which line wave-lengths are readily read off. (The fringes are slightly bent, the Fraunhofer lines appearing straight, thin, and sharp.)

For example, for the stronger D line of sodium (D_2), I found, after 275 fringes had passed, that the interferometer screw had been moved 0.162 mm from the "white-light" position. Therefore, from the above formula the wave-length is obtained as 5890 angstroms.

If, having made such a count of moving fringes, we leave a fringe of known number on a given line, then the fringe system superimposed on the spectrum gives a natural scale of frequencies. From (1) it follows that the wave-length λ_2 of some other Fraunhofer line farther toward the violet will be given by

$$(n + \tfrac{1}{2})\,\lambda = (n + r + \tfrac{1}{2})\,\lambda_2 \qquad (2)$$

where r is the number of fringes, now stationary, between the original and the new line, and λ_2 is the wave-length of the new line. For higher values of n, equation (2) simplifies to

$$n/(n + r) = \lambda_2/\lambda \qquad (3)$$

Here λ_2, the wave-length of the second line, is in inverse ratio to the fringe number, which represents the frequency. Hence the frequency-difference, or the reciprocal of the wave-length-difference between any two fringes in the field of view is constant. Where n is greater than 100, the last formula may be used, for the inaccuracy incurred by dropping the $\tfrac{1}{2}$ is small compared to observational inaccuracy.

Thus the wave-length of every line in the visible spectrum can be obtained by one count of moving fringes followed by one count of stationary fringes. The accuracy of the method depends on the observer's care in making his observations. It is an excellent exercise for students.

My attention was called to this type of fringe by J. Q. Stewart and A. S. Fairley.

PRINCETON UNIVERSITY, MARCH, 1928.

PLANET NOTES FOR SEPTEMBER AND OCTOBER.

By CLIFFORD E. SMITH.

The *Sun* will be moving southeast from the central part of Leo to the eastern part of Virgo. On September 23, at about 7:00 A.M., C.S.T., the sun will pass through the Autumnal Equinox which marks the beginning of fall. The positions of the sun on September 1, October 1, and October 31 will be, respectively: R.A. $10^h\,39^m$, Decl. $+8°\ 33'$; R.A. $12^h\,27^m$, Decl. $-2°\ 55'$; and R.A. $14^h\,19^m$, Decl. $-13°\ 53'$.

The phases of the *Moon* will occur as follows:

New Moon	Sept.	3 at	6 A.M.	C.S.T.
First Quarter		10 "	5 P.M.	"
Full Moon		18 "	5 P.M.	"
Last Quarter		25 "	8 P.M.	"
New Moon	Oct.	2 "	4 P.M.	"
First Quarter		10 "	12 M.	"
Full Moon		18 "	6 A.M.	"
Last Quarter		25 "	2 A.M.	"

The moon will be at apogee (farthest from the earth) on September 12 and October 10, and at perigee (nearest the earth) on September 28 and October 22.

Mercury will be in the central part of Virgo. It will be at a stationary point in its orbit on September 25 and on October 16. Its apparent motion will be direct until September 25, retrograde from this date until October 16, and after October 16 direct again. On September 15 it will be in conjunction with the moon, and on September 10 and on September 23 it will be in conjunction with Mars. On September 12 it will be at greatest elongation east and at that time will set about an hour and a half after the sun. On October 8 it will be at inferior conjunction, and on October 23 at greatest elongation west. On the latter date Mercury will rise about an hour before the sun.

Venus will be moving apparently eastward from the western part of Cancer, across Leo to the central part of Virgo. On September 27 it will be in conjunction with Neptune and at that time will be distant from Neptune about half the diameter of the moon. On September 30 and on October 30 it will be in conjunction with the moon. During this period it will rise about two hours before the sun.

Mars will be in Virgo and its apparent motion will be direct. During the latter part of September it will be near the bright star Spica. On September 5 and on October 4 it will be in conjunction with the moon and on September 10 and on September 23 it will be in conjunction with Mercury. It will be an evening star during this period and it will set about an hour after the sun during the middle of this period.

Jupiter will be in Taurus. On October 5 it will be at a stationary point in its orbit. Before this date its apparent motion will be direct, after this date retrograde. On September 24 and October 22 Jupiter will be in conjunction with the moon. On September 8 it will be in quadrature west of the sun, and thus during the first part of this period it will be near the meridian at sunrise.

Saturn will be in the southern part of Ophiuchus. Its apparent motion will be direct. On September 11 and on October 8 it will be in conjunction with the

moon. On September 17 Saturn will be in quadrature east of the sun, thus the middle part of September it will be near the meridian at sunset.

Uranus will be in central Pisces. Its apparent motion will be retrograde. On September 19 and on October 17 it will be in conjunction with the moon. On October 3 it will be in opposition with the sun, thus it will be visible most of the night hours during this period.

Neptune will be in Leo. Its apparent position will be near that of the sun during this period since opposition occurred on August 24. The only point of interest may be the conjunction with Venus on September 27 when it will be distant from Venus only about half the diameter of the moon.

METEOR NOTES.

By CHARLES P. OLIVIER.

Due to the writer's probable absence, after June 20, for a few weeks, it has become necessary to prepare these notes considerably ahead of time. This means that unreported work, which advance letters have informed us has been done, will have to wait until the fall to be reviewed. However, enough has already arrived to give quite interesting results. The tables below will give the usual data as to hourly rates and radiants.

The only observations on the Eta Aquarids mentioned here are those made by our Texas observers, all five gathered at Burleson, Texas, for the occasion. This statement should be qualified to include only those who live in Ft. Worth and Dallas, as we have other members in the state, which indeed leads all others in its membership in the A.M.S. Meteors were not numerous, but enough Aquarids were seen for three observers to determine radiants. The night of May 4 was said to be an excellent one, but only a very few 5 magn. meteors were recorded and none of the 6 magn. The Aquarids are intimately connected with Halley's Comet. We already know that they were splendidly observed in New Zealand this year, for many nights.

R. C. Shinkfield at Adelaide, S. Australia, observed for Lyrids on April 19 and 20. He saw 36 meteors on the two nights in 225 minutes of observing, but reported that no Lyrids whatever were noted. McIntosh in New Zealand, the next night, secured an excellent radiant from 6 Lyrids. Seven in all were seen, four being of 1 magn. or brighter, having in general long paths, long durations, and enduring trains. The Moon was only two days from full. The writer does not remember that a Lyrid radiant has been determined in the past from so far south. This report brings the total number of meteors observed by McIntosh in 1929 to 368. His work, done as it is in the Southern Hemisphere, is filling a long-felt want, namely to have a really skillful and trained meteor observer work regularly on the meteors in the southern skies.

In the long table of radiants given by McIntosh, it will be noted that the same radiant frequently was determined on one or more nights after its first appearance. This makes the existence of such radiants doubly sure. It is a matter of opinion whether it is best to combine radiants, determined by 2 to 5 meteors on a given night, into a mean position for the mean date. As errors of observation make it usually impossible to detect motion night by night, perhaps for these small showers combinations of 3-day periods are quite permissible. But in all

cases great care should be taken to explain what has been done. Combinations that run to a week or more are to be heartily condemned on many grounds, and lead to quite impossible results.

Nine fireballs were reported from ships, including 4 on April 25 and 26. It is a pity that duplicate observations are not more frequent. Two fireballs in the early evening of May 15 were seen by four observers—two for each—in New York and Philadelphia. While heights may be deducible from the observations at hand, we would like to have others as checks for both objects, which must have been seen by many persons.

All observers who contributed to our work in 1918 to 1925 will have received before reading this the publication containing their work. It is distributed to them from here as *Flower Observatory Reprint* No. 4; it is actually Part I, Vol. 5, *Publications of the McCormick Observatory*, University of Virginia, and as such will go from that Observatory to its regular mailing list. Flower Observatory Reprints No. 1, 2, and 3 have been sent to all present members of the A.M.S. Any member, who fails to receive these publications by the time he reads this, will please notify the undersigned, giving his present address.

We wish to welcome as a new member Mr. John A. Kingsbury, 49 Wall Street, New York City.

It is hoped that everyone will do his best to observe the great summer showers and send in a creditable amount of work for those months when the observing conditions are so easy. A similar society in Russia reported over 17,000 observations last year—more than four times as many as were made by the A.M.S. Cannot our inactive members do better?

R. A. McIntosh, Auckland, New Zealand.
(New Zealand Mean Time)

		Began	Ended	Min.	Meteors	Rate	Factor	Cor. Rate
1929 April	5	2:30	4:00	90	13	8.7	0.7	12.4
	6	2:30	4:45	135	26	11.6	.9	12.9
	7	1:00	2:20	57	13	13.7	.6	22.8
	14	3:36	5:05	83	16	11.6	.7	16.6
	16	2:30	5:08	158	40	15.2	1.0	15.2
	17	2:45	5:10	130	30	13.8	.9	15.3
	18	2:40	5:00	140	29	12.4	1.0	12.4
	22	2:45	5:23	158	37	14.1	.6	23.5

R. C. Shinkfield, Adelaide, South Australia.
(No Lyrids)

		Began	Ended	Min.	Meteors	Rate	Factor	Cor. Rate
April	19	15:30	17:45	135	16	7.1	1.0	7.1
	20	16:00	17:30	90	20	13.3	...	...

Millard Bennett (and two), Fort Wayne, Indiana.
(Central Standard Time)

		Began	Ended	Min.	Meteors	Rate	Factor	Cor. Rate
May	29	8:30	11:33	183	14	4.9	0.8	6.1

B. S. Whitney, Lawton, Oklahoma.
(Central Standard Time)

		Began	Ended	Min.	Meteors	Rate	Factor	Cor. Rate
May	31	10:25	14:00	215	16	4.5	0.8	5.6

R. Brown, S. Bunch, J. H. Logan, O. E. Monnig, B. Sanders (in order), Burleson, Texas.
(Central Standard Time)

		Began	Ended	Min.	Meteors	Rate	Factor	Cor. Rate
May	4	11:30	15:50	260	35	8.1	1.0	8.1
	4	14:08	16:01	113	13	7.0	1.0	7.0
	4	14:50	16:00	70	13	11.1	1.0	11.1
	4	11:17	16:01	284	42*	8.9	1.0	8.9
	4	11:	15:53	?	21	...	1.0	...

*29 plotted, 8 of these Aquarids.

Radiants.

No.			α	δ	Meteors	Wt.	Observer
1	May	4.89	335°.5	— 1°.	5	Fair	Logan; Aquarids
2		4.88	336.	— 2.	4-7	Fair	Bunch; Aquarids
3		4.85	235.	+25.	5	Good	Sanders
4		4.85	234.	—18.	3	Poor	Sanders
		4.82	229.	—16.	2	Poor	Brown
		4.82	230.	—16.	3	Poor	Monnig
5		4.82	248.	— 9.	3	Fair	Monnig
6		4.82	269.5	+27.5	4	Good	Monnig
7		4.82	334.	— 1.	4	Good	Monnig; Aquarids

April Meteor Radiants by McIntosh.

1929 April	No.	R.A.	Dec.	Meteors	Wt.	Remarks
3-6 c.	112	241°.0	— 4°.0	5	Good	1 on Apr. 3, 1 on Apr. 4, 2 on Apr. 5, 1 on Apr. 6. AMS 983, Apr. 9, 251°, —7°; D. 187, 4, Mar., 247°, +1°; D. 187, 5, Apr. 18-May 13, 244°, +7°. See also D. 178.
3-6 c.	113	261.5	—32.0	7	Good	1 on Apr. 3, 2 on Apr. 4, 3 on Apr. 5, 1 on Apr. 6. D. 210, 2, 270°, —27°, Apr. 15-24 may be the termination of above shower.
4-6 c.	114	230.0	—21.0	8	Good	4 on Apr. 4, 2 on Apr. 5, 2 on Apr. 6. BAA 21, Apr. 1, 236°, —19°; See D. 171 and 178.
4-6 c.	115	247.5	—50.0	7	V.G.	3 on Apr. 4, 2 on Apr. 5, 2 on Apr. 6. See D. 189.
4-6 c.	116	285.0	—53.0	7	Good	1 on Apr. 4, 5 on Apr. 5, 1 on Apr. 6.
5-6 c.	117	212.0	—13.0	6	Good	3 on Apr. 5, 3 on Apr. 6. BAA, Apr. 8, 208°, —10°, D. 166, 4, Apr. 11, 216°, —10°; D. 166, 8, Apr. 21, 214°, —13°; D. 158, 11, Apr. 7-16, 210°, —10°; AMS 924, Apr. 12, 208°, —19°.
13.70	118	232.5	—20.5	6	Good	Probably very active, as clouds hid region most time. See Nos. 122, 127, 132, 139.
13.70	119	270.0	—10.0	4	Fair	See Nos. 124, 128, 134.
13.70	120	307.5	—65.0	4	Good	See Nos. 125, 137, 131.
15.68	121	152.5	—67.0	3	Fair	
15.68	122	233.5	—20.0	3	Good	See Nos. 118, 127, 132, 139.
15.68	123	260.0	—36.0	10	Ex.	Short zenith meteors. See 133.
15.68	124	269.0	— 9.0	4	Fair	See 119, 128, 134.
15.68	125	301.0	—68.0	2	?	See 120, 131, 137.
15.68	126	301.0	—31.0	5	Good	See 130, 138, 143. One meteor on Apr. 14.

1929 April	No.	R.A.	Dec.	Meteors	Wt.	Remarks
16.69	127	238.3	—21.0	4	Good	See 118, 122, 132, 139.
16.69	128	267.0	—10.0	2	Poor	See 119, 124, 134.
16.69	129	288.0	+ 7.7	7	Ex.	See 136, 142.
16.69	130	300.0	—30.5	4	Good	See 126, 138, 143.
16.69	131	300.0	—53.0	3	Fair	See 120, 125, 137.
17.68	132	232.5	—21.0	2	?	See 118, 122, 127, 139.
17.68	133	258.5	—42.5	6	Ex.	See 123. Also 1 on Apr. 16.
17.68	134	269.0	—10.0	3	Good	See 119, 124, 128.
17.68	135	273.5	—28.5	5	Good	2 on Apr. 16, 4 on Apr. 17.
17.68	136	290.0	+ 7.0	2	?	See 129, 142.
17.68	137	297.0	—57.5	2	?	See 120, 125, 131.
17.68	138	300.0	—30.5	2	?	See 126, 130, 143.
21.69	139	238.5	—21.7	3	Fair	See 118, 122, 127, 132.
21.69	140	272.2	+32.7	6	Ex.	Lyrids.
21.69	141	277.0	—34.7	7	Ex.	
21.69	142	289.3	+ 2.5	7	Ex.	See 129, 136.
21.69	143	303.0	—30.0	4	Good	See 126, 130, 138.

Flower Observatory, Upper Darby, Pennsylvania, 1929 June 17.

Brilliant Meteor Observed. —On the evening of May 25 at 9:42 E.S.T. I observed a large meteor which appeared at first like an ordinary red shooting star with apparent location in R.A. 18^h, Decl. $+20°$. I was about to turn away when I noticed it began to brighten and appeared to gain speed, the red color turned to white and increased in size to about 300″ in diameter. At this stage red sparks were easily seen behind and the center ones were the longest.

The path appeared slightly curved while red but as soon as it started to brighten just south of β and γ Lyrae it was straight through Cygnus. The general direction was northeast.

H. Webb.

9251 173rd St., Jamaica, L. I., N. Y., July 5, 1929.

Meteor Observed.— The undersigned reports that he saw a very brilliant meteor on the evening of July 10, at about 9:45. It began in Virgo, continued north at an elevation of about 45°, then seemed to arch down toward the horizon, and disappeared behind some nearby trees, probably at about the northern part of Leo. No sound was heard, and the meteor was still traveling rapidly with steady speed and brilliance when lost to view.

While estimates of those in the party differed, the duration was probably about 6 or 7 seconds. The meteor carried a train which stretched over a distance of 12° to 15°. "The head gave a definite impression of being more dense in composition and was red to orange-red; following this was an area that appeared to be in the nature of a flame with sections shading from green to blue. Finally, in the rear was a field of what appeared to be sparks."

Any reader who may have seen this meteor is urged to record his observation as accurately as possible, and send it to the American Meteor Society, care of Flower Observatory, Upper Darby, Pennsylvania, for comparison with this report and any others that may be received.

G. H. England.

Box 352, Fostoria, Ohio.

COMET NOTES.

By G. VAN BIESBROECK.

Except for the faint COMET 1929 *a* (SCHWASSMANN-WACHMANN), which was found on January 17 and which remained quite inconspicuous until it disappeared after five months of visibility, this year has not so far brought further additions to the list of comets.

With large instruments it is still possible to see COMET 1927 *d* (STEARNS) under favorable conditions. The writer saw it with the 40-inch refractor on June 15, 29, and July 5 as a round coma some 15″ in diameter with a small central condensation. This unsharp nucleus is, however, not brighter than a 16^{M} star and the total light-impression is hardly $15^{M}.5$. The deviation from the ephemeris given in the June number (p. 347) is still less than one minute of arc. The comet has now been watched for two years and four months since the discovery in March, 1927, and its distance from the sun now reaches 700 million miles, more than half-way between the distances of Jupiter and Saturn from the sun. The brightness changes very little at the present time so that further observations on this far-away comet are to be expected. As far as I know, only one comet has been followed for a longer time at one apparition, namely COMET 1889 I (BARNARD), of which there was an isolated observation two years and seven months after it was discovered at the Lick Observatory.

F. R. Cripps has computed definite elements for PERIODIC COMET 1896 V (GIACOBINI) which has not been reobserved since the first apparition. He has brought these elements up to 1929 and applied the perturbations by Jupiter during the five intervening revolutions. The period of 6.65 years found at first is now shortened to 6.43 years and this year's perihelion passage falls on September 24. There is of course a great uncertainty in this prediction after such a long interval of time but Cripps' search ephemeris (*Journal of the British Astr. Assoc.*, Vol. 39, p. 261) will be of interest for those who expect to hunt up the object:

SEARCH EPHEMERIS FOR PERIODIC COMET 1896 V.

0^{h} U.T.	Perihelion 1929 Sept. 21			Perihelion Sept. 29		
	h m	° ′	log. dist.	h m	° ′	log. dist.
1929 July 31	18 22.3	+7 37	9.763	17 41.8	+4 40	9.821
Aug. 8	23.0	6 35	.754	44.1	3 35	.818
16	29.0	5 6	.749	49.8	2 7	.817
24	37.5	3 13	.749	17 58.9	+0 23	.820
Sept. 1	18 49.6	+1 3	.752	18 11.6	−1 31	.824
9	19 5.2	−1 16	.759	27.5	3 31	.831
17	24.1	3 33	.770	18 46.5	5 30	.840
25	19 46.1	5 42	.785	19 8.3	7 21	.852
Oct. 3	20 9.9	−7 36	9.805	19 32.7	−8 59	9.867

The position is predicted for two different assumptions in regard to the time of perihelion. The region of the comet was explored here with a wide-angle camera (July 10) but no trace of the object was found on the plates. Theoretically it will be somewhat brighter in August and September so that the search is still hopeful.

Comet hunters should also direct their attention to periodic comet Perrine, an ephemeris of which was given on p. 246. Although it is unfavorably situated at this apparition the best chances of finding it come in August, when it rises

about three hours before the sun. But the prediction is quite uncertain.

The same remark applies to PERIODIC COMET METCALF for which G. Merton has computed elements according to which the next perihelion passage comes on November 23 (*British Astr. Assoc. Handbook for 1929*, p. 33). His search-ephemeris can only indicate in a general way in what part of the sky the object is to be expected after remaining unobserved for three revolutions (Period 7.73 years):

SEARCH EPHEMERIS FOR PERIODIC COMET METCALF.

0h U.T.	Perihelion Nov. 19.0		Perihelion Nov. 27.0	
	h m	° ′	h m	° ′
1929 Aug. 7	23 35.4	+11 56	23 9.4	+10 41
23	43.2	11 31	11.8	9 56
Sept. 8	46.5	9 13	10.0	7 19
24	47.1	+ 4 56	7.5	2 57
Oct. 2	23 49.1	— 0 26	23 9.1	— 2 6

F. Seagrave writes that in working on the orbit of PERIODIC COMET PONS-WINNECKE he notes that in 1930 the course of this comet will be perturbed considerably by an approach to Jupiter, the minimum distance on July 28 of that year being 0.503 astronomical units.

As a result of his statistical study of all the material gathered on cometary spectra since the application of the spectroscope, F. S. Hogg makes interesting suggestions for future work in this field (*Journal of the Royal Astron. Soc. of Canada*, Feb., 1929). He emphasizes the efficiency of the objective prism as the best method for finding the absolute energy as a function of wave-length. The lens should be of short focal length in order to reduce the size of the image of the comet; sufficient dispersion can be secured by means of large-angle prisms. The lens should be rapid and have a wide field in order to record on the same plate a large range of comparison stars having a known energy-distribution. Standard sensitometer exposures should be added for determining the gradient of the plates. This method will furnish a very much more complete photometric analysis than the mere estimation of integrated brightness. Slit-spectrograph records on bright comets near the sun are desirable for further identification of unknown lines.

Williams Bay, Wisconsin, July 19, 1929.

VARIABLE STARS.

Monthly Report of the American Association of Variable Star Observers, for the Months of May and June, 1929.

Members of the Association will be glad to learn that our Secretary, Mr. W. T. Olcott, is now apparently well on the road to recovery from what, for a time, appeared to be a very serious illness. For the next few months all communications concerning the Association should be addressed to the Recording Secretary, Harvard Observatory, Cambridge, Mass.

A grand total of nearly 900 observations made by Sig. Lacchini during May and June well attests the efforts he is putting into variable star work under the clear skies of Catania, Italy. Mr. A. S. Grossman of Denver, Colorado, sends in his first report. May there be many others.

U Geminorum, after an interval of more than eight months of apparent

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

April 0 = J.D. 2425702; May 0 = J.D. 2425732; June 0 = J.D. 2425763.

J.D.Est.Obs.

V Scl
000339
671[13.3 Bl
700[11.6 Bl
714[13.3 Bl

S Scl
001032
598 8.1 Kd
609 8.4 Kd
623 9.1 Kd
671 11.6 Bl
716 13.0 Dw

X And
001046
710 12.9 Lj
719 12.0 Lj
721 11.8 Lj
731 10.6 Lj
736 10.5 Lj
740 10.2 Lj
753 9.9 Lj
754 9.1 Lj
756 9.9 Lj
761 9.8 Lj
763 9.7 Lj

T Cet
001620
597 6.6 Kd
598 6.5 Kd
609 6.5 Kd
610 6.5 Kd
621 6.5 Kd
623 6.4 Kd
624 6.4 Kd
626 6.5 Kd
641 6.1 Kd
652 6.0 Kd

T And
001726
766 10.8 Pt

T Cas
001755
716 10.9 L
731 11.0 L
742 9.2 L
757 9.1 L
765 9.8 Jo
766 9.0 Pt
767 8.6 Jo
774 8.8 Jo

S Tuc
001862
671[13.2 Bl
684[12.4 En
700 12.9 Bl
710 12.2 Bl

T Scl
002438a
716 13.3 Dw

J.D.Est.Obs.

T Phe
002546
671 13.5 Bl
700[13.0 Bl
716[13.6 Dw

W Scl
002833
671 13.0 Bl
716 13.4 Dw

U Cas
004047a
742 12.5 L
757 11.4 L
766 10.7 Pt

— Cas
004047a
766 10.6 Pt

RW And
004132
757 13.0 L

X Scl
004435
671 12.0 Bl
680 12.0 Bl
700 12.1 Bl

RR And
004533
742 10.5 L
757 11.0 L

RV Cas
004746a
704 10.8 L
721 10.9 L
731 11.0 L
742 11.1 L
757 12.0 L
766 12.2 Pt

— Cas
004746b
704 10.3 L
721 10.4 L
731 10.5 L
742 10.8 L
757 11.0 L

W Cas
004958
765 9.6 Jo
767 9.4 Jo

U Tuc
005475
671 9.3 Bl
676 9.6 En
680 9.9 Bl
683 9.8 En
687 10.1 Ht
699 10.6 Ht
700 11.0 Bl
701 11.0 En
706 11.3 En

J.D.Est.Obs.

U Tuc
005475
710 12.1 Bl
732 12.5 Ht
732 12.5 Sm

Z Cet
010102
761 8.8 L

U Scl
010630
671[13.2 Bl
700[12.0 Bl

U And
010940
757[12.1 L

UZ And
011041
703 10.8 L
757 13.1 L

S Cas
011272
742[13.2 L

R Scl
012333a
598 7.9 Kd
623 7.8 Kd
626 7.7 Kd
641 7.3 Kd
652 7.0 Kd

RZ Per
012350
718 11.6 L
742 11.7 L
757 12.7 L

RU And
013238
703 10.8 L
757 12.6 L
766 12.6 Pt

Y And
013338
757[12.5 L
766 13.8 Pt

X Cas
014958
734 11.6 Bn
744 11.4 Bn
751 11.3 Bn
766 10.0 Pt

U Per
015254
688 8.0 GC
697 8.5 Bw
706 8.0 Ah
716 8.2 Ah
718 8.3 Ah
719 8.3 Ah
721 8.3 Ah
721 8.4 Ah

J.D.Est.Obs.

U Per
015254
734 8.4 Ah
738 8.4 Ah
740 8.4 Ah
742 8.4 Ah
745 8.4 Ah
751 8.4 Ah
752 8.5 Ah
758 8.7 Ah
760 8.8 Ah
762 8.6 Ah
766 8.9 Pt

W And
021143a
697 8.0 Bw
706 7.4 Ah
766 7.9 Pt

T Per
021258
706 8.7 Ah
718 8.7 Ah
738 8.8 Ah
762 8.8 Ah

Z Cep
021281
716 11.3 L
725 11.8 L
726 11.6 Sf
737 12.2 Wn
739 12.1 L
748 12.0 L
757 12.5 L
766 13.5 Pt

o Cet
021403
595 6.8 Kd
597 7.0 Kd
598 7.1 Kd
600 7.2 Kd
609 7.4 Kd
610 7.4 Kd
621 7.7 Kd
623 7.7 Kd
624 7.8 Kd
626 7.8 Kd
641 8.7 Kd
676 9.3 En

S Per
021558
688 9.4 GC
706 9.3 Ah
718 9.3 Ah
738 9.4 Ah
762 9.3 Ah

RR Per
022150
697[13.4 Bw
716[13.4 L

J.D.Est.Obs.

R For
022426
671 8.7 Bl
680 8.7 Bl
700 9.0 Bl
710 9.7 Bl

RR Cep
022980
727[14.0 L

R Tri
023133
706 6.1 Ah
725 5.8 Wn
776 8.1 Sf

W Per
024356
715 9.9 Gb

R Hor
025050
671 6.9 Bl
676 6.8 En
680 6.9 Bl
683 7.1 En
687 7.2 Ht
697 6.9 En
698 6.9 Ht
698 6.9 Dr
700 7.4 Bl
701 7.7 En
705 7.3 Dr
706 7.0 Dw
710 7.6 Bl
713 7.3 Dr
713 7.5 Dw
717 7.6 Bl
728 7.8 Dr
735 7.8 Dr

T Hor
025751
672 8.0 Bl
676 8.5 En
680 8.1 Bl
683 8.6 En
687 8.5 Ht
697 9.3 En
698 9.4 Ht
698 9.6 Dr
700 9.2 Bl
701 9.3 En
705 9.8 Dr
706 9.9 Dw
710 9.6 Bl
713 10.2 Dr
713 10.5 Dw
717 10.6 Bl
728 11.5 Dr
735 12.2 Dr

J.D.Est.Obs.

AA Per
030846
686 9.7 By

Y Per
032043
725 8.6 Ty
732 8.6 Ty
734 8.5 Ty
738 8.5 Ty
742 8.5 Ty

R Per
032335
697[12.3 Bw
716[12.0 L

U Eri
034625
704[12.3 En
707[12.3 En

T Eri
035124
698 7.9 Dr
704 9.3 En
705 8.1 Dr
706 8.5 En
706 8.3 Dw
713 8.6 Dw
713 8.7 Dr
714 8.5 En

W Eri
040725
698 10.2 Dr
705 10.2 Dr
706 10.1 Dw
713 10.3 Dw
728 10.5 Dr
735 11.4 Dr

RY Cam
042164
672 8.2 By
686 8.2 By
687 8.2 By
698 8.2 By
699 8.3 By
707 8.5 By
715 8.7 By
718 8.9 By
723 9.1 By
730 9.3 By

T Cam
043065
710 12.1 An
718 11.6 L
720 10.9 Be
720 11.0 An
725 10.7 L
727 10.8 An
727 10.5 Be
731 10.3 BL
739 9.6 BL

Variable Star Observations Received During May and June, 1929.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

T Cam
043065
739 9.4 Pt
739 9.3 L
742 9.4 BL
748 8.9 L
759 8.5 L
759 8.8 Be

RX Tau
043208
687[12.2 Ht
698[12.2 Ht

R Ret
043263
672 12.5 Bl
681 12.5 Bl
700 13.0 Bl
701 13.4 Dr
706 13.2 Dw
710 13.2 Bl
712 13.6 Dr
728 11.9 Dr
729 11.8 Dr
729 11.9 Dw
732 11.8 Ht
732 12.2 Sm
735 11.7 Dr

X Cam
043274
672 9.8 By
686 9.1 By
687 9.0 By
698 9.0 By
699 9.1 By
707 9.2 By
711 9.8 B
714 9.9 By
715 10.1 By
716 10.3 L
718 10.4 By
723 11.2 By
725 11.3 L
730 11.9 By
735 12.2 B
739 12.5 Pt
739 12.5 L
748 12.9 L
759 12.5 L

R Dor
043562
672 5.6 Bl
676 5.6 En
681 5.4 Bl
683 5.6 En
687 5.5 Ht
698 5.4 Ht
700 5.5 Bl
701 5.5 Dr
701 5.3 En
706 5.4 En

R Dor
043562
710 5.5 Bl
713 5.5 En
715 5.5 Dr
717 5.5 Bl
725 5.3 En
728 5.2 Dr
731 5.5 Bl
732 5.2 Ht
732 5.8 Sm
735 5.0 Dr

R Cae
043738
672[12.5 Bl
687[12.0 Ht
700[12.5 Bl
712 13.7 Dw
712 13.7 Dr
729 13.4 Dr
732[12.0 Ht
735 12.8 Dr

R Pic
044349
672 8.5 Bl
676 8.2 En
681 8.7 Bl
684 9.0 En
688 9.1 Ht
697 8.9 Dw
697 8.9 Dr
699 9.0 Ht
700 9.1 Bl
701 9.1 En
701 8.9 Dr
705 8.9 Dr
706 9.2 En
710 9.1 Bl
714 9.2 En
715 9.2 Dr
717 9.1 Bl
728 9.0 Dr
729 9.2 En
732 8.8 Bl
732 9.2 Ht
732 9.0 Sm
735 8.7 Dr
735 9.1 Dw

TT Tau
044528
686 8.7 By
687 8.7 By
698 8.5 By
699 8.5 By
705 8.5 By

V Tau
044617
711 13.3 B

R Ori
045307
711 12.7 B
721 12.4 L

ε Aur
045443
703 4.2 Be
709 4.2 Be
719 4.1 Be
732 4.0 Be
736 4.0 Be

R Lep
045514
703 8.6 L
718 9.0 L

V Ori
050003
711 10.5 B
722 10.2 L

T Lep
050022
672 9.6 Bl
681 9.7 Bl
700 10.2 Bl
701 10.7 En
706 10.5 En
710 10.5 Bl
714 11.0 En
717 10.5 Bl
729 11.3 En

S Pic
050848
672 13.4 Bl
676[12.9 En
684[12.9 En
700[13.4 Bl
701[12.9 En
706[12.2 En
728[12.2 En
732[12.2 Sm

R Aur
050953
706 8.6 Ah
707 8.5 Ch
718 7.7 Ah
719 7.8 Ah
721 7.5 Ah
722 7.6 Ah
724 7.7 Ah
726 7.6 Sw
734 7.5 Ah
737 7.5 Lg
738 7.5 Pt
738 7.5 Ah
740 7.8 Ah
742 7.7 Ah
743 7.9 Ah
745 8.0 Ah
751 7.7 Ah
752 7.6 Ah

R Aur
050953
757 8.0 Ah
758 7.9 Ah
760 8.0 Ah
762 8.0 Ah

T Pic
051247
672 10.2 Bl
676 9.5 En
681 10.8 Bl
684 10.6 En
688 11.5 Ht
698 11.9 Dr
699 12.2 Ht
700 11.7 Bl
701 12.0 En
705 12.8 Dr
706 12.9 Dw
710 13.6 Bl
713 13.9 Dr
713 13.4 Dw
729 14.3 Dw
738 14.3 Dr
729 14.5 Dr
738 14.3 Dw

Nov Tau
051316
721 13.2 L

T Col
051533
672 7.8 Bl
676 7.8 En
681 7.3 Bl
683 7.9 En
688 7.5 Ht
697 7.6 Dr
697 7.6 Dw
699 7.5 Ht
700 7.5 Bl
701 7.6 Dr
701 7.8 En
705 7.8 Dr
706 7.7 Dw
706 8.2 En
710 8.3 Bl
713 8.2 Dw
714 8.3 En
715 8.4 Dr
717 8.4 Bl
728 9.5 Dr
732 9.6 Ht
732 10.0 Sm
735 10.1 Dw
735 9.9 Dr

S Aur
052034
710 10.2 An
720 9.6 An
720 9.1 Be

S Aur
052034
728 9.6 Sp
738 8.3 Pt

W Aur
052036
707[13.1 Ch
710 13.1 An
711 13.0 B
721 13.5 L
732[12.1 Ty
739[13.2 L
742[11.6 Ty

RR Cam
052372
672 10.6 By
686 10.6 By
698 10.7 By
707 10.8 By
714 10.8 By
718 10.7 By
723 10.8 By
730 10.8 By

S Ori
052404
689 9.9 GC
703 10.2 L
705 10.8 An
705 10.1 Be
710 10.7 An
711 10.9 An
711 10.9 Be
714 11.0 B
715 10.5 Pt
716 10.1 L
717 9.8 L
718 10.0 L
721 9.9 L
725 10.0 L

AN Ori
053005f
703 11.6 L
716 11.6 L
717 11.7 L
718 11.7 L
719 11.6 L
722 11.6 L

S Cam
053068
719 8.8 Ah
721 8.8 Ah
724 8.9 Ah
724 8.6 BL
728 8.7 BL
729 8.6 BL
731 8.5 BL
738 8.5 Pt
738 8.9 Ah
739 8.8 BL
740 8.6 Ah
742 8.7 Ah
742 8.8 BL
743 8.7 Ah
745 7.8 Ah
751 8.8 Ah
752 8.8 Ah
758 8.8 Ah
760 8.7 Ah
762 8.8 Ah

RR Tau
053326
705 12.1 Nz
717 12.6 Nz
727 13.2 Nz

RU Aur
053337
723 10.4 Sf
724 10.1 Lg
737 10.0 Lg
738 11.4 Pt
739 10.2 Sf
742 10.7 Wn
751 9.8 Lg

U Aur
053531
706 10.1 Ah
707 10.2 Ch
725 11.1 Sf
733 11.3 B
737 10.8 Lg

Y Tau
053920
716 7.2 Kl

SU Tau
054319
703 10.7 L
710 10.2 An
711 10.3 An
711 10.3 Be
712 9.8 B
715 9.9 Pt
716 10.0 L
717 9.9 L
721 10.2 An
721 10.4 L
722 10.0 L
724 10.8 Lg

Variable Star Observations Received During May and June, 1929.

J.D.Est.Obs.

SU Tau
054319
725 10.5 L
726 10.9 L
727 11.1 L
727 11.0 Be
727 10.8 B
727 11.2 An
728 10.8 Sp
728 11.6 L
729 11.5 B
730 12.1 L
732 12.1 L
733 12.3 Wn
733 11.8 B
734 12.2 L
736 11.9 L
737 12.0 L
737 11.0 Lg
739 10.9 Pt
739 12.0 L
741 11.4 L
741 12.2 L
742 11.2 L
746 11.1 L
748 10.7 L
750 10.8 L

S Col
054331
672 11.9 Bl
676 12.6 En
681 12.1 Bl
688 12.6 Ht
700 13.0 Bl
701 12.6 En
710 13.2 Bl
713[12.2 En
732[12.6 Ht

Z Tau
054615a
717 12.0 Nz
722 12.3 L
727 12.2 Nz
728 12.7 Sf
732[12.8 L

RU Tau
054615c
717[13.5 Nz
722[13.5 L
727[14.7 Nz
732[12.8 L

R Col
054629
672 10.7 Bl
676 10.9 En
681 11.9 Bl
684 11.7 En
688 11.7 Ht
699 12.6 Ht
700 11.9 Bl

J.D.Est.Obs.

R Col
054629
701 11.9 Dr
701 12.4 En
705 12.4 Dr
706 12.6 Dw
710 12.7 Bl
713 12.6 Dw
715 13.0 Dr
738 14.1 Dw
738 13.8 Dr

α Ori
054907
703 0.7 L
718 0.6 L
721 0.8 L
726 0.5 L

U Ori
054920a
706 11.0 Ah
707 10.8 Ch
727 10.5 Gb
728 11.6 Ch
729 11.3 B

V Cam
054974
714 13.2 B
722 13.5 L
724 12.5 Wn
767[13.5 L

Z Aur
055353
672 10.2 By
686 10.0 By
687 10.1 By
698 10.2 By
699 10.2 By
707 10.3 By
714 10.3 By
715 10.6 Pt
723 10.0 Pt
724 10.1 Pt
725 10.1 Pt
727 10.6 B
729 10.5 Pt
733 10.2 Pt
738 10.2 Pt
739 10.2 Pt
741 10.0 Pt
748 10.0 Pt
761 10.6 Pt
763 10.7 Pt

R Oct
055686
672 11.8 Bl
676 11.6 En
681 11.7 Bl
685 11.6 En
687 11.6 Ht
699 11.6 Ht

J.D.Est.Obs.

R Oct
055686
700 11.6 Bl
701 11.5 Dr
702 11.5 En
706 11.6 Dw
710 11.5 Bl
712 11.2 En
713 11.4 Dr
713 11.2 Dw
717 11.4 Bl
728 11.0 Dr
731 11.1 Bl
732 11.2 Ht
735 10.8 Dw
738 10.0 Dr
747 9.6 Dr

X Aur
060450
707 9.5 Ch
708 9.5 Lj
710 9.6 Lj
710 8.8 Ch
711 9.2 B
711 8.9 Ch
715 8.8 Lj
719 8.7 Lj
721 8.7 Lj
724 8.4 Wn
727 8.8 B
728 8.2 Ch
729 8.7 Lj
730 8.7 Lj
732 8.6 Wn
736 8.7 Lj
738 8.3 Pt
742 8.6 Sf
743 8.7 Lg
743 8.7 Wn
753 9.2 Lj
754 9.3 Lj

V Aur
061647
711 10.3 B
721 10.7 L
724 10.5 Lg
728 10.6 Sp
730 10.3 L
734 10.3 L
740 9.4 Ty
743 10.3 Lg
745 9.1 Ty
746 9.6 L
756 8.9 L
756 8.9 Be

AG Aur
062047
721 10.7 L
726 10.9 L
730 10.7 L

J.D.Est.Obs.

AG Aur
062047
734 10.4 L
739 10.1 L
746 9.9 L
756 9.5 L
756 9.4 Be
763 9.3 Be
763 9.4 L

U Lyn
063159
714 14.1 B

R Mon
063308
729 11.8 B

Nov Pic
063462
673 7.7 En
683 7.7 En
687 7.7 Ht
697 7.5 En
698 7.3 Ht
701 7.7 En
705 7.5 En
707 7.6 En
713 7.7 En
728 7.7 En
732 7.7 Ht

S Lyn
063558
710 11.7 Ch
724 12.3 Wn
727 12.6 L
731 12.9 Bw
731 12.4 Sf
733 12.3 Wn
733 12.5 B
734 13.1 L
738 14.2 Pt
740 13.1 Bw
742 12.9 Wn
747 13.3 Bw
748 13.4 L
759 13.6 L

X Gem
064030
697 13.0 Bw
729 12.6 B
731 12.7 Bw
732 11.7 Ty
733 11.9 Ty
734 12.3 Bn
737 11.9 Lg
740 11.8 Ty
740 12.3 Bw
741 12.1 Bn
745 11.6 Ty
747 11.5 Bw

J.D.Est.Obs.

W Mon
064707
735 9.7 B

Y Mon
065111
686 9.4 GC
688 9.5 GC
698 10.4 GC
699 10.4 GC
707 11.3 Ch
708 10.7 GC
709 11.1 GC
727 13.0 L
728 12.8 Ch
729 13.0 B
736 13.6 L

X Mon
065208
686 8.2 By
687 8.2 By
698 8.3 By
699 8.3 By
705 8.4 By
710 8.5 By
714 8.6 By
716 7.7 L
718 8.6 By
725 8.2 L
736 8.4 L

R Lyn
065355
710[13.3 Ch
714[13.4 B
721 13.4 L
730 13.3 L
734 12.8 L
748 12.0 L
759 11.3 L
759 11.0 Be

V CMi
070109
707[12.7 Ch
724[12.1 Wn
731[13.0 B
736 14.5 L

R Gem
070122a
706 10.2 Ah
707 10.3 Ch
724 11.1 Sw
728 10.6 Al
728 11.0 Sp
728 11.0 Wd
728 10.7 Ch
729 11.0 Eb
729 10.8 Kz
737 10.9 Lg
738 11.5 Pt
742 11.3 Wd

J.D.Est.Obs.

Z Gem
070122b
729[12.1 Kz
738 12.5 Pt
761 12.5 Pt

TW Gem
070122c
729 8.4 Kz
729 8.4 Eb
738 8.1 Pt
761 8.1 Pt

R CMi
070310
706 10.8 Ah
707 10.8 Ch
716 9.5 L
718 10.4 Ah
719 10.3 Ah
724 9.8 Wn
725 9.4 L
729 9.5 B
736 9.2 L
737 9.3 Wn
743 9.4 Wn
746 9.2 L
757 9.1 L
757 8.9 Be

R Vol
070772
678[13.4 En
699[13.4 Ht
712 13.2 Dr
712 13.7 Dw
717 13.6 Dw
717 12.8 Dr
732[13.4 Ht
732[12.6 Sm
735 13.8 Dw
735 14.0 Dr
738 13.2 Dr
738 13.2 Dw
747 12.7 Dr

L_2 Pup
071044
697 3.9 Dr
701 4.2 Dr
705 4.3 Dr
713 4.3 Dr
728 4.4 Dr
734 4.6 Dr
743 5.0 Dr
747 4.7 Dr

RR Mon
071201
699 11.3 GC
703 11.4 L
707 11.4 Ch
708 11.5 GC
709 11.3 GC
721 11.5 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RR MON	S VOL	W PUP	V CNC	X UMA	V UMA
071201	*073173*	*074241*	081617	083350	090151
728 12.1 Sf	731 9.2 Bl	732 11.9 Sm	732 9.5 Ty	761 10.7 Pt	737 9.8 L
730 12.0 L	732 9.4 Ht	T GEM	733 9.5 Ty	S HYA	738 9.9 B
731 12.0 GC	732 9.2 Sm	074323	736 9.6 L	084803	747 10.1 L
733 11.6 Ty	735 9.2 Dr	686 9.0 GC	738 9.8 Pt	700 9.7 Ch	757 10.3 Be
736 11.9 L	735 9.2 Dw	688 9.1 GC	740 9.1 Ty	706 9.0 Ah	757 10.5 L
737 12.1 Wn	738 9.0 Dr	689 9.1 GC	745 9.0 Ty	707 9.5 Ch	W CNC
737 11.8 Lg	743 9.2 Dr	697 9.6 Bw	746 9.1 L	718 8.9 Ah	090425
750 12.3 L	747 9.3 Dr	698 9.1 GC	756 9.0 L	719 8.8 Ah	707 11.4 Ch
V GEM	U CMI	699 9.0 GC	756 8.9 Be	721 8.7 Ah	710 11.5 An
071713	073508	702 9.1 Ch	761 9.0 Pt	724 8.6 Ah	716 11.0 L
699 12.0 GC	710 12.9 An	703 9.0 GC	RT HYA	724 8.6 Lg	721 10.9 An
707 12.2 Ch	711 13.0 B	708 9.0 GC	*082405*	728 8.0 B	724 10.3 Wn
708 12.8 GC	716 12.8 L	709 9.1 GC	738 7.7 Pt	732 8.1 Ty	725 10.4 Sf
709 12.3 GC	720 12.5 An	710 9.0 Ch	R CHA	733 8.0 Ty	727 10.0 L
716 13.1 L	720 12.5 Be	729 8.7 Kz	*082476*	738 7.9 Ah	732 9.4 Sf
727 13.2 L	725 12.1 L	729 8.6 Eb	672 8.5 Bl	738 7.9 L	732 9.4 Wn
731 13.4 GC	725 11.5 Ty	731 8.0 GC	676 9.0 En	740 7.9 Ty	732 8.6 Ty
731 13.2 B	731 11.1 Ty	735 8.5 B	681 9.3 Bl	743 7.8 Lg	733 8.8 Ty
736 14.0 L	732 10.9 Ty	738 8.6 Pt	683 9.5 En	745 7.9 Ty	736 8.6 L
742 13.9 Bw	733 10.8 Ty	740 8.7 Bw	700 10.3 Bl	751 7.7 Ah	739 8.5 B
757 13.6 L	736 10.8 L	743 8.9 Lg	702 10.6 En	751 7.5 Lg	740 8.2 Ty
S CMI	738 11.5 Pt	748 9.0 Bw	706 10.9 En	752 7.7 Ah	741 8.6 Sf
072708	740 10.5 Ty	751 8.8 Lg	710 10.9 Bl	761 7.7 Pt	742 8.5 Wn
707 12.2 Ch	745 10.4 Ty	761 9.0 Pt	714 11.3 En	T HYA	743 8.1 Lg
728 12.7 B	746 10.7 L	U PUP	717 10.9 Bl	*085008*	745 8.1 Ty
738 12.4 Pt	757 9.7 Be	*075612*	729 11.8 En	707 11.0 Ch	746 7.9 L
T CMI	757 9.7 L	710[13.2 Ch	731 11.3 Bl	721 10.0 L	754 8.2 Sf
072811	S GEM	731[12.2 Ty	732 11.8 Sm	724 10.1 Lg	756 7.9 L
711 14.3 B	073723	736[13.2 L	U CNC	728 9.8 B	756 7.9 Be
736 14.3 L	702 9.2 Ch	R CNC	083019	730 9.7 L	759 8.2 B
Z PUP	710 8.8 Ch	081112	688 9.4 GC	736 9.4 L	762 8.1 Sf
072820b	729 9.1 Kz	700 8.2 Ch	689 9.5 GC	743 9.5 Lg	773 8.2 Sf
704 14.5 Nz	729 9.3 Eb	706 7.1 Ah	699 9.5 GC	746 9.3 L	RX UMA
705 14.4 Nz	729 9.2 Bw	707 7.1 Ah	702 9.5 Ch	751 8.5 Lg	090567
709 14.6 Nz	735 9.6 B	716 7.1 Ah	708 9.2 GC	756 9.0 Be	721 11.3 L
717 14.5 Nz	738 9.6 Pt	718 7.0 Ah	716 9.6 L	756 9.1 L	730 11.4 L
727 14.3 Nz	740 10.1 Bw	719 7.0 Ah	728 10.1 B	T CNC	737 11.3 L
732 14.0 Nz	743 9.8 Lg	721 6.9 Ah	728 10.4 Bw	085120	747 11.3 L
S VOL	747 10.1 Bw	724 7.0 Ah	729 10.1 Sf	724 8.5 BL	757 11.3 L
073173	751 8.9 Lg	726 7.0 Wd	731 10.3 GC	728 8.6 BL	RW CAR
672 11.8 Bl	761 10.6 Pt	728 6.8 B	732 10.1 Sf	729 9.0 BL	*091868*
678 12.4 En	W PUP	734 7.0 Ah	733 9.8 Wn	731 9.1 BL	672[13.0 Bl
681 12.0 Bl	*074241*	738 7.1 Ah	736 10.2 L	733 9.2 BL	684[12.8 En
687 11.6 Ht	672 9.0 Bl	738 6.6 Pt	740 10.9 Bw	738 7.9 L	701[13.3 Bl
699 11.4 Ht	676 9.0 En	742 6.8 Sc	741 10.8 Sf	739 8.9 BL	712 14.3 Dw
700 10.8 Bl	681 8.9 Bl	743 7.4 Lg	742 10.4 Wn	742 9.0 BL	712 14.3 Dr
701 11.1 Dr	683 8.5 En	751 7.3 Ah	743 10.7 Lg	754 9.0 BL	717 14.0 Dr
702 11.4 En	688 9.1 Ht	751 7.2 Lg	746 11.1 L	761 8.3 Pt	717 14.3 Dw
705 11.0 Dw	699 8.9 Ht	752 7.2 Ah	748 11.4 Bw	T PYX	735 13.4 Dr
705 11.1 Dr	701 8.9 En	758 7.3 Ah	751 11.1 Lg	*090031*	735 13.4 Dw
706 11.0 En	701 9.0 Bl	761 8.0 Pt	756 11.6 L	701 [w Bl	Y VEL
710 10.4 Bl	706 9.4 En	V CNC	759 11.8 B	V UMA	*092551*
713 10.2 Dw	711 9.3 Bl	081617	X UMA	090151	672 13.1 Bl
714 10.0 En	713 10.1 En	707 12.3 Ch	083350	710 10.6 An	678 12.4 En
715 10.1 Dr	718 10.3 Bl	725 9.8 Ty	738 10.9 Pt	720 10.3 An	681 13.1 Bl
717 9.7 Bl	728 11.2 En	728 9.9 B	739 11.1 B	720 10.6 Be	684 12.4 En
728 9.5 Dr	731 11.5 Bl	730 9.9 L	743 10.8 Lg	721 10.1 L	687 12.4 Ht
729 9.5 En	732 11.9 Sm	731 9.5 Ty	759 11.0 B	730 9.9 L	698 12.4 Ht

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
Y VEL			**X HYA**			**R LEO**			**Z VEL**			**S CAR**			**W VEL**		
092551			*093014*			094211			*094953*			*100661*			*101153*		
700	13.0	Bl	738	8.4	Pt	722	9.6	BL	735	13.1	Dr	684	6.4	En	731	9.6	En
705	13.8	Dw	751	8.2	Lg	724	9.5	Ah	**V LEO**			687	6.0	Ht	732	9.8	Ht
707	12.4	En	**Y DRA**			724	9.6	BL	095421			697	6.8	En	**U HYA**		
710	12.7	Bl	093178			726	9.6	Wd	688	12.9	GC	697	6.6	Dr	*103212*		
712	12.5	Dw	721	13.4	L	728	9.4	B	689	12.8	GC	697	6.6	Dw	625	5.7	Ka
712	12.3	Dr	730	13.9	L	728	9.6	BL	699	12.7	GC	698	6.7	Ht	629	5.7	Ka
713	12.3	Dw	737	14.4	L	728	9.8	Sw	703	12.4	GC	701	6.8	Dr	631	6.1	Kd
713	12.4	En	759	14.4	L	729	9.8	Kz	708	12.3	GC	701	6.9	Bl	643	5.9	Kd
717	11.6	Bl	**R LMI**			729	9.9	Eb	712	11.6	Ch	704	6.9	En	645	5.9	Kd
728	9.7	Dr	093934			729	9.7	BL	724	10.1	Wn	705	7.2	Dw	646	5.5	Ka
729	9.8	En	706	9.3	Ah	731	9.7	BL	731	10.2	Sf	705	6.9	Dr	648	6.0	Kd
731	9.2	Bl	718	8.6	Ah	733	9.6	BL	732	9.8	Wn	707	7.1	En	650	5.6	Ka
732	9.5	Ht	721	7.7	Ah	734	9.2	Ah	738	10.1	Pt	710	7.5	Bl	652	5.4	Ka
732	9.5	Sm	722	7.8	Ah	735	9.6	BL	739	10.1	B	713	7.6	Dw	656	6.0	Kd
735	9.1	Dr	724	7.6	Ah	735	9.6	Wd	741	9.8	Sf	713	7.6	Dr	659	6.0	Kd
738	9.0	Dr	725	7.4	Hs	738	8.7	Pt	742	9.8	Wn	714	7.5	En	670	6.0	Kd
743	8.6	Dr	728	7.0	Al	738	9.0	Ah	754	9.7	Sf	717	7.8	Bl	678	6.0	Kd
747	8.5	Dr	728	7.1	Sw	739	9.3	Sw	757	9.9	Sf	728	8.4	Dr	683	5.6	Ka
R CAR			732	7.0	Hs	739	9.5	BL	760	9.8	Pt	729	8.7	En	707	6.0	Kd
092962			734	6.8	Ah	742	9.5	BL	762	10.1	Sf	730	8.5	Dr	711	6.1	Kd
672	4.9	Bl	735	6.9	B	742	9.0	Wd	762	10.2	B	731	8.9	Bl	714	5.5	Ka
676	5.1	En	737	6.9	Hs	742	9.4	Sc	766	10.2	Sf	732	8.7	Ht	715	6.1	Kd
681	5.0	Bl	738	6.5	Pt	742	8.8	Ah	**RV CAR**			732	9.2	Sm	716	5.3	L
684	5.1	En	738	6.7	Ah	743	8.9	Ah	*095563*			734	8.6	Dr	727	5.3	L
687	5.7	Ht	739	6.6	Sw	746	8.9	Ah	672	13.2	Bl	735	8.5	Dw	729	6.1	Kd
697	5.9	En	740	6.6	Ah	747	8.9	BL	681	12.5	Bl	738	8.6	Dr	730	5.8	Ka
697	5.7	Dw	742	6.5	Ah	751	8.7	Ah	684	12.0	En	743	8.5	Dr	733	5.9	Ka
698	5.7	Ht	**742**	6.8	Gy	752	8.6	Ah	701	11.5	Bl	747	8.3	Dr	736	5.4	L
701	5.8	Dr	743	6.6	Ah	754	8.8	BL	702	11.5	En	**Z CAR**			746	5.3	L
701	5.6	Bl	745	6.6	Ah	757	8.2	Wd	702	11.3	Dr	*101058a*			756	6.0	Kd
704	5.9	En	751	6.4	Ah	758	8.7	BL	705	11.4	Dr	672	13.2	Bl	755	5.3	L
705	6.1	Dr	752	6.5	Ah	758	8.3	Ah	705	11.2	Dw	678	[12.3	En	756	5.2	Be
705	6.2	Dw	757	6.6	Ah	760	8.2	Ah	707	11.6	En	701	[12.6	Bl	760	5.4	L
706	6.0	En	758	6.5	Ah	760	8.2	Pt	710	11.4	Bl	702	[12.3	En	761	5.3	Be
710	6.1	Bl	760	6.6	Ah	762	7.9	B	713	11.3	Dw	707	[12.3	En	**RZ CAR**		
713	6.3	Dr	761	6.3	Pt	762	8.5	BL	714	11.3	En	712	13.9	Dr	*104270*		
713	6.5	Dw	762	6.6	Ah	764	8.1	BL	717	11.3	Bl	712	13.4	Dw	697	10.6	Dr
714	6.5	En	764	6.7	Sw	765	6.6	Jo	730	11.4	Dr	725	14.6	Dw	701	11.0	Dr
717	6.4	Bl	773	6.5	Jo	772	6.5	Jo	731	11.4	Bl	735	14.9	Dr	705	11.5	Dr
728	6.9	Dr	**RR HYA**			772	7.7	BL	731	11.6	En	**AF CAR**			705	11.2	Dw
729	7.6	En	*094023*			773	7.0	Jo	738	11.6	Dr	*101058b*			705	11.3	En
731	6.8	Bl	702	13.8	Dr	773	7.5	BL	738	11.8	Dw	712	15.1	Dr	713	11.6	Dr
732	7.2	Dr	705	13.6	Dr	774	7.4	BL	743	12.0	Dr	735	15.1	Dr	713	11.7	Dw
732	8.2	Ht	713	13.7	Dr	781	7.0	BL	747	12.2	Dr	**W VEL**			730	12.8	Dr
735	7.7	Dw	730	13.5	Dr	**Y HYA**			**RY LEO**			*101153*			738	13.4	Dr
738	7.7	Dw	738	13.2	Dr	*094622*			095814			672	8.9	Bl	738	13.3	Dw
738	7.3	Dr	**R LEO**			738	6.3	Pt	712	8.9	Kl	678	8.7	En	**R UMA**		
743	7.9	Dr	094211			**Z VEL**			713	8.9	Kl	681	8.7	Bl	103769		
X HYA			706	9.8	Ah	*094953*			716	8.9	Kl	685	8.7	En	703	8.7	Ch
093014			710	10.1	An	678	[12.8	En	717	8.9	Kl	687	8.5	Ht	706	8.8	Ah
705	9.4	Nz	711	10.1	Be	698	[12.8	Ht	729	9.0	Kl	698	8.7	Ht	716	9.3	Ah
717	9.0	Nz	712	10.0	Ch	701	[13.3	Bl	736	9.1	Kl	701	9.1	Bl	718	9.4	Ah
724	8.1	Lg	716	9.8	Ah	702	[12.8	En	740	9.2	Kl	702	9.0	En	719	9.4	Ah
727	8.3	Nz	718	9.6	Ah	712	14.0	Dr	**S CAR**			707	9.0	En	721	9.6	Ah
728	8.5	B	719	9.5	Ah	712	14.3	Dw	*100661*			710	9.0	Bl	724	8.9	Sw
732	8.5	Nz	721	10.0	An	732	[12.8	Ht	672	5.8	Bl	713	9.3	En	724	9.8	Ah
737	8.4	Lg	722	9.2	Ah	735	13.7	Dw	678	6.4	En	717	9.0	Bl	726	10.0	Sw
									681	6.1	Bl	731	9.5	Bl	728	10.0	Sw

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R UMA	S LEO	AD CEN	T VIR	T CVN	R VIR
103769	110506	*114858*	*120905*	122532	123307
728 9.8 Al	759 10.4 L	687 9.7 Ht	733 11.0 Ty	747 11.0 BL	738 9.5 Pt
729 10.1 Kz	759 10.5 Be	692 9.4 Ht	736 11.3 L	754 11.1 BL	738 9.5 Ah
729 10.0 Eb	760 10.3 Pt	706 9.2 En	737 11.4 Wn	758 11.3 BL	740 9.6 Ah
734 10.3 Ah	RY CAR	713 9.1 En	738 11.5 Pt	760 11.8 Pt	742 9.7 Ah
735 10.5 Wd	*111561*	731 9.1 En	740 11.2 Ty	762 11.2 BL	743 9.8 Ah
738 10.8 Pt	681 13.8 Bl	732 9.5 Ht	743 11.8 Lg	764 11.3 BL	745 10.0 Ah
738 10.5 Ah	701 12.7 Bl	W CEN	745 11.3 Ty	772 11.4 BL	760 11.0 Pt
739 10.7 B	702 12.1 Dr	*115058*	747 12.0 L	773 11.5 BL	774 10.8 Sw
742 10.9 Wd	706 11.7 Dw	672 8.4 Bl	759 12.5 L	774 11.7 BL	RS UMA
757 11.0 Wd	705 11.9 Dr	681 8.6 Bl	759 12.0 Be	Y VIR	123459
759 11.2 B	710 11.6 Bl	684 9.4 En	R CRV	*122803*	720 13.6 Nz
760 11.4 Pt	713 10.9 Dr	687 9.6 Ht	*121418*	713 9.2 Nz	732 12.8 Nz
V HYA	714 11.0 Dw	697 9.4 En	711 9.7 An	717 9.7 L	738 11.8 L
104620	717 10.7 Bl	698 9.9 Ht	711 9.7 Be	720 9.6 Nz	741 11.2 Br
672 7.6 Bl	730 10.2 Dr	701 9.7 Bl	713 10.2 Nz	726 9.7 L	743 11.6 Lg
681 7.5 Bl	731 10.3 Bl	702 9.5 En	717 10.4 L	728 9.6 B	760 9.5 Pt
701 7.7 Bl	734 10.2 Dr	706 10.0 En	720 10.3 Nz	732 9.7 Nz	765 8.6 Jo
710 7.6 Bl	738 10.4 Dr	710 10.3 Bl	721 10.1 An	733 9.8 Ty	769 8.5 Jo
718 7.7 Bl	743 10.7 Dr	713 10.7 En	728 10.7 L	734 9.9 Br	S UMA
721 7.3 L	747 10.4 Dr	717 10.9 Bl	728 10.0 Wd	736 10.0 L	123961
730 7.3 L	RS CEN	731 11.3 Bl	731 10.9 Hs	740 10.1 Ty	706 10.0 Ah
731 7.2 Bl	*111661*	731 11.7 En	732 10.8 Nz	743 10.1 Lg	708 10.3 Lj
736 7.3 L	672 9.4 Bl	732 11.9 Ht	735 10.5 B	745 10.2 Ty	710 10.3 Lj
738 6.8 Pt	678 8.9 En	732 12.2 Sm	736 11.1 L	747 10.3 L	711 10.0 Ch
747 7.4 L	681 9.2 Bl	R COM	738 10.9 Pt	759 10.9 L	715 10.5 Lj
759 6.9 L	684 8.9 En	115919	742 11.1 Wd	759 10.7 Be	718 10.4 Ah
759 7.1 Be	697 8.9 Dr	724 7.6 BL	743 11.0 Eb	U CEN	719 10.4 Ah
760 7.1 Pt	701 8.7 Dr	728 7.7 BL	743 11.1 Kz	*122854*	719 10.6 Lj
RS HYA	701 8.7 Bl	729 7.7 BL	747 11.2 L	672 9.5 Bl	720 10.7 Be
104628	702 8.8 En	731 7.7 BL	759 11.8 L	681 10.3 Bl	720 10.8 An
672 10.9 Bl	705 8.9 Dr	733 7.8 BL	759 11.7 B	701 11.0 Bl	721 10.5 Lj
681 10.0 Bl	706 9.0 Dw	735 7.8 BL	759 11.8 Be	710 11.5 Bl	727 10.9 An
701 9.5 Bl	707 9.1 En	735 8.0 B	760 11.7 Pt	717 12.0 Bl	728 11.0 Al
710 9.2 Bl	710 9.1 Bl	738 8.2 Pt	SS VIR	731 13.0 Bl	729 11.1 Lj
718 10.0 Bl	713 9.2 Dr	739 7.7 BL	*122001*	T UMA	730 11.2 Lj
731 10.3 Bl	713 9.2 En	742 7.8 BL	711 9.9 An	123160	733 11.2 B
W LEO	714 9.3 Dw	743 7.9 Lg	711 9.0 Be	706 10.4 Ah	734 11.0 Ah
104814	717 9.2 Bl	747 7.9 BL	717 9.1 L	711 11.0 Ch	736 11.3 Lj
724 12.5 Wn	728 9.3 Dr	754 8.3 BL	721 10.0 An	726 10.9 Sw	738 11.0 Pt
732 13.2 Nz	731 9.7 En	758 8.7 BL	726 8.5 L	728 12.2 Al	738 11.3 Ah
736 12.9 L	731 9.7 Bl	760 9.4 Pt	735 9.0 B	729 11.9 Eb	740 11.4 Lj
737 10.4 Wn	734 9.9 Dr	762 9.0 BL	736 8.8 L	729 12.0 Kz	742 11.0 Ah
739 12.7 B	738 10.2 Dr	764 9.3 BL	747 8.3 L	733 12.1 B	742 10.6 An
743 12.7 Lg	743 10.7 Dr	772 9.3 BL	759 8.3 L	738 12.5 Pt	743 11.2 Lg
746 12.7 L	747 11.0 Dr	773 9.3 BL	759 8.4 Be	741 12.5 Dr	753 11.5 Lj
759 12.2 L	X CEN	774 9.4 BL	T CVN	743 12.6 Lg	757 11.7 Lj
RS CAR	*114441*	781 9.7 BL	122532	760 12.6 Pt	757 11.0 Wd
110361	672 8.8 Bl	SU VIR	724 10.5 BL	R VIR	758 11.3 Ah
707[12.3 En	681 9.3 Bl	120012	728 10.5 BL	123307	760 11.5 Ah
S LEO	701 10.6 Bl	734[12.5 Br	728 10.2 Al	706 6.9 Ah	760 11.8 Pt
110506	701 10.4 Dr	735[12.7 B	729 10.5 BL	707 6.9 Ah	761 11.6 Lj
703 12.6 GC	710 11.1 Bl	743 12.8 Lg	731 10.6 BL	716 7.2 Ah	765 11.5 Jo
708 12.2 GC	713 11.0 Dr	T VIR	733 10.5 BL	718 7.4 Ah	RU VIR
728 11.2 L	714 11.3 Dw	*120905*	738 11.3 Pt	719 7.4 Ah	124204
736 10.6 L	717 11.3 Bl	717 10.6 L	739 10.6 BL	721 7.5 Ah	703 12.0 GC
738 11.1 Pt	730 12.1 Dr	728 11.1 L	742 10.7 BL	722 7.6 Ah	717 12.3 L
743 10.8 Lg	732 12.6 Bl	728 10.7 B	743 11.2 Kz	734 9.1 Ah	727 12.6 L
747 10.7 L	743 12.7 Dr	731 11.2 Sf	743 11.2 Eb	735 9.0 B	734 12.2 Br

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RU VIR			U OCT			S VIR			T CEN			RX CEN			R CEN		
124204			*131283*			*132706*			*133633*			*134536*			*140959*		
736	12.5	L	743	11.8	Dr	712	9.9	En	734	7.4	Dr	710	10.0	Bl	672	5.9	Bl
738	13.0	Pt	747	11.4	Dr	728	9.2	En	735	7.1	Kd	717	10.0	Bl	673	6.2	En
747	12.6	L	W VIR			728	9.3	Sp	743	6.8	Dr	732	11.0	Bl	681	5.9	Bl
759	12.9	L	*132002*			732	9.6	Sm	747	6.8	Dr	T APS			684	6.0	En
760	12.8	Pt	737	10.0	Lg	737	8.7	Lg	765	6.2	Kd	*134677*			687	5.7	Ht
U VIR			739	10.8	B	738	8.9	B	RT CEN			672	9.0	Bl	695	6.0	En
124606			759	10.0	B	738	8.6	Pt	*134236*			678	9.1	En	698	6.0	Ht
706	8.9	Ah	V VIR			739	8.7	Hs	672	9.3	Bl	681	9.2	Bl	701	5.9	Bl
710	8.4	Ch	*132202*			742	8.3	Sc	674	9.6	En	685	9.2	En	702	6.2	Dr
716	8.6	Ah	717	8.2	L	760	7.3	Pt	681	9.2	Bl	687	9.5	Ht	702	6.2	En
717	8.0	L	726	8.4	L	RV CEN			686	9.5	En	699	9.7	Ht	705	6.4	Dr
718	8.5	Ah	728	8.6	Sp	*133155*			688	9.4	Ht	701	9.4	Bl	713	6.3	Dw
719	8.4	Ah	736	8.4	L	672	8.4	Bl	699	9.2	Ht	702	9.5	En	715	6.3	En
721	8.4	Ah	737	8.7	Lg	681	8.6	Bl	701	9.2	Bl	702	9.8	Dr	717	6.5	Bl
726	7.9	L	747	8.3	L	701	8.6	Bl	702	9.5	En	707	9.7	En	728	6.6	En
728	8.6	B	759	8.4	L	702	8.0	Dr	702	9.0	Dr	710	10.0	Bl	730	7.0	Dr
734	8.4	Ah	759	8.4	Be	710	8.5	Bl	705	9.4	Dr	713	10.0	Dr	732	6.7	Ht
736	8.1	L	759	8.8	B	714	8.2	Dw	710	9.3	Bl	713	9.8	Dw	732	6.5	Sm
738	8.2	Pt	RR UMA			717	8.5	Bl	712	9.5	En	717	10.4	Bl	734	6.7	Dr
738	8.5	Ah	132262			731	8.3	Bl	714	9.2	Dw	730	10.8	Dr	738	7.1	Dr
740	8.4	Ah	672	10.0	By	743	7.9	Dr	715	9.4	Dr	732	11.1	Ht	743	7.3	Dr
742	8.4	Ah	686	10.8	By	T UMI			717	9.3	Bl	732	11.7	Sm	U UMI		
743	8.5	Ah	R HYA			133273			730	9.6	En	743	11.5	Dr	141567		
743	8.5	Lg	*132422*			714	13.3	B	730	9.5	Dr	RR VIR			708	10.8	Lj
745	8.5	Ah	631	7.4	Kd	722	12.4	L	731	9.4	Bl	*135908*			710	10.8	Lj
747	8.4	L	649	8.0	Kd	736	11.9	L	732	9.5	Ht	737	11.3	Wn	715	10.8	Lj
752	8.6	Ah	672	8.2	Bl	737	12.2	Wn	732	9.6	Sm	738	11.2	Pt	718	10.5	Lj
757	8.8	Ah	774	8.5	En	743	12.2	Br	735	9.5	Dr	743	10.3	Lg	719	10.7	Lj
758	8.8	Ah	678	8.5	En	746	11.7	L	747	9.6	Dr	760	11.3	Pt	721	10.6	Lj
759	8.6	L	681	8.9	Bl	760	11.6	L	R CVN			Z BOO			727	9.8	B
759	8.7	Be	686	8.9	En	767	11.3	Sf	134440			140113			729	9.9	Lj
760	8.9	Ah	688	9.0	Ht	T CEN			706	9.0	Ah	717	13.3	L	730	9.8	Lj
760	8.7	Pt	699	9.2	Ht	*133633*			715	9.0	Gb	728	14.0	L	733	9.8	Al
762	9.1	Ah	701	9.1	Bl	631	7.1	Kd	718	8.9	Ah	729	13.7	B	736	9.8	Lj
RV VIR			702	9.3	En	649	7.7	Kd	719	8.8	Ah	736	14.0	L	738	8.6	Pt
130212			706	9.3	Ch	672	6.0	Bl	721	9.0	Ah	743	13.4	Wn	740	9.6	Lj
714	11.7	B	710	9.2	Bl	673	6.2	En	724	8.7	Ah	743	14.2	Br	750	9.2	Lj
717	11.9	L	712	9.4	En	678	6.2	En	725	8.6	Ty	760	14.2	L	751	9.3	Ah
727	12.0	L	715	9.5	En	681	6.2	Bl	734	8.4	Ah	Z VIR			752	9.2	Ah
731	12.5	Sf	717	9.4	Bl	686	6.3	En	738	8.0	Pt	*140512*			753	9.2	Lj
736	12.8	L	717	9.3	L	688	6.2	Ht	740	8.3	Ah	717	11.7	L	756	9.1	Lj
737	12.5	Wn	728	9.2	L	698	6.2	Ht	740	8.4	Ty	726	11.8	L	757	9.1	Lj
747	13.3	L	728	9.5	En	701	6.0	En	742	8.1	Gy	736	12.2	L	757	9.2	Ah
759	13.8	L	731	9.3	Bl	701	6.0	Bl	742	8.3	Ah	746	12.2	L	758	9.1	Ah
U OCT			732	9.7	Ht	702	5.8	Dr	743	8.3	Ah	760	13.1	L	760	9.0	Ah
131283			732	10.1	Sm	705	6.1	Dr	751	8.1	Ah	RU HYA			760	9.0	Pt
672	13.6	Bl	736	9.3	L	707	6.2	Kd	752	8.0	Ah	*140528*			761	9.1	Lj
676	12.9	En	738	9.5	Pt	710	6.2	Bl	757	7.8	Ah	672	12.5	Bl	762	8.9	Ah
685	12.9	En	747	9.3	L	712	6.3	En	758	7.8	Ah	674	12.5	En	S BOO		
687	13.2	Ht	759	9.7	L	713	6.4	Dr	760	7.9	Ah	688	12.5	Ht	141954		
699	13.2	Ht	760	9.6	Pt	714	6.5	Dw	760	7.5	Pt	701	13.3	Bl	706	9.4	Ch
701	13.6	Bl	S VIR			715	6.4	En	762	7.7	Ah	702	13.1	Dr	711	8.7	Be
707	12.9	En	*132706*			717	6.2	Bl	771	8.2	Gb	711	13.3	Bl	711	8.8	An
713	12.9	En	686	11.0	En	728	7.0	En	RX CEN			712	13.7	Dr	721	8.2	An
732	12.7	Sm	688	11.5	Ht	730	7.2	Dr	*134536*			712	13.5	Dw	722	8.1	L
735	12.2	Dr	704	10.1	En	731	7.0	Bl	672	8.7	Bl	738	14.3	Dw	727	8.1	B
732	12.7	Ht	706	11.1	Ch	732	7.4	Ht	681	9.4	Bl				731	7.7	L
735	12.2	Dw	710	10.5	Ch	732	7.4	Sm	701	10.3	Bl				736	7.7	L

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
S Boo			R Cam			R Boo			T Lib			RU Lib			S UMi		
141954			142584			143227			*150519*			*152714*			153378		
738	7.8	Pt	672	8.6	By	762	8.2	Wd	717	14.1	L	717	8.4	L	719	11.3	Lj
743	8.1	Kz	686	8.6	By	763	8.2	Lj	742	12.4	Ty	726	8.0	L	730	11.4	Lj
743	7.9	Eb	689	8.6	By	765	8.0	Jo	Y Lib			736	8.1	B	736	11.3	Lj
743	8.2	Br	698	8.7	By	769	8.4	Jo	*150605*			736	7.6	L	737	11.0	Lg
746	7.9	L	707	8.7	By	772	8.5	Jo	717	14.0	L	738	8.1	Pt	738	10.8	Pt
760	8.6	L	711	8.7	Ch	V Lib			728	13.9	L	746	8.0	L	740	11.3	Lj
760	8.0	Pt	715	9.0	By	*143417*			736	13.4	L	760	8.5	L	750	10.6	Lj
769	9.4	Jo	727	9.3	B	717	11.1	L	738	13.1	B	760	8.0	Pt	753	10.5	Lj
772	9.5	Jo	730	9.3	By	728	11.2	L	746	13.2	L	R Nor			756	10.5	Lj
RS Vir			743	10.3	Br	736	11.6	L	760	12.4	L	*152849*			757	10.5	Lj
142205			R Boo			742	11.8	Ty	S Lib			673	10.0	En	760	10.0	Pt
717	12.8	L	143227			746	12.1	L	*151520*			681	9.2	Bl	761	10.4	Lj
720	12.6	Nz	706	9.4	Ah	760	13.0	L	717	8.3	L	682	9.3	En	U Lib		
728	13.3	L	706	9.2	Ch	U Boo			727	8.4	L	685	9.4	En	*153620a*		
729	13.2	B	708	9.5	Lj	144918			736	8.5	L	688	8.8	Ht	702	12.6	Dr
729	13.3	Nz	710	9.0	Lj	714	9.8	B	738	8.7	Pt	693	8.8	En	714	12.6	Bl
736	13.5	L	715	8.7	Lj	727	10.1	B	746	9.3	L	699	8.2	Ht	715	11.7	Dr
743	13.5	Br	716	8.4	Ah	743	10.3	Lg	760	10.3	Pt	701	7.7	Bl	718	11.7	Bl
746	13.4	L	718	8.2	Ah	Y Lup			761	10.2	Be	702	7.7	Dr	730	10.1	Dr
760	13.8	L	718	8.6	Lj	*145254*			761	10.4	L	705	7.7	Dr	735	10.0	Dr
V Boo			719	8.5	Lj	672	13.7	Bl	S Ser			707	8.2	En	747	9.8	Dr
142539a			719	8.3	Ah	686	12.4	En	151714			711	7.4	En	T Nor		
697	8.4	Sc	721	8.0	Ah	701	13.7	Bl	717	13.6	L	711	7.6	Bl	*153654*		
706	7.8	Ch	721	8.2	Lj	707	12.4	En	728	13.8	L	713	7.4	Dw	682	8.1	En
706	8.1	Ah	722	7.9	Ah	712	15.3	Dr	736	13.5	L	713	7.4	Dr	685	8.3	En
707	8.1	Ah	724	7.8	Ah	712	15.2	Dw	743	11.1	Lg	715	7.4	En	688	8.7	Ht
711	8.2	An	727	7.6	B	730	12.4	En	743	13.6	Br	718	7.6	Bl	699	8.8	Ht
711	8.0	Be	728	7.1	Sw	738	15.2	Dw	746	13.8	L	730	7.5	Dr	702	8.8	Dr
715	7.5	Gb	729	7.6	Hs	S Aps			760	13.4	L	730	7.8	En	708	9.3	En
716	8.2	Ah	729	7.6	Lj	*145971*			S CrB			732	7.5	Sm	711	9.5	En
718	8.1	Ah	730	7.3	Lj	672	13.4	Bl	151731			735	8.0	Dr	713	9.7	Dw
719	8.1	Ah	734	7.9	Ah	681	13.8	Bl	631	7.8	Kd	743	8.0	Dr	713	9.5	Dr
721	8.1	Ah	736	7.2	Lj	682	13.9	Bl	706	10.8	Ch	747	7.8	Dr	730	10.5	En
721	8.1	An	737	7.1	Hs	701	13.0	Dr	738	11.8	B	X Lib			730	10.1	Dr
722	8.1	Ah	737	8.2	Wd	701	13 6	Bl	738	11.9	Pt	*153020*			732	10.3	Sm
724	8.2	Ah	738	7.5	Pt	702	12.9	Dr	743	11.8	Kz	682	11.9	Bl	734	10.3	Dr
727	8.2	B	738	7.8	Ah	705	12.7	Dr	743	11.5	Eb	701	12.0	Bl	743	10.5	Dr
733	7.9	Al	739	7.2	Sw	711	13.6	Bl	743	11.3	Br	711	12.7	Bl	Z Lib		
734	8.2	Ah	740	7.8	Ah	713	12.7	Dr	760	12.0	Pt	W Lib			*154020*		
738	8.2	Ah	740	7.3	Lj	713	13.1	Dw	RS Lib			*153215*			682	13.5	Bl
738	7.8	Pt	742	7.8	Ah	714	13.3	Bl	*151822*			682	12.8	Bl	714	13.0	Bl
740	8.0	Ah	742	8.2	Wd	714	13.2	Dw	681	11.0	Bl	702	11.1	Dr	747	13.1	Dr
742	8.0	Ah	743	6.4	Kz	715	12.9	Dr	685	11.4	En	711	10.8	Bl	R CrB		
743	8.0	Ah	743	6.9	Eb	716	13.0	Dw	688	11.4	Ht	711	11.0	Ch	154428		
743	8.2	Kz	743	7.7	Ah	718	12.9	Bl	701	11.2	Bl	715	11.1	Dr	625	5.8	Ka
743	8.0	Eb	745	7.8	Ah	728	13.2	En	702	11.7	En	717	10.9	L	631	6.0	Kd
745	8.0	Ah	750	7.5	Lj	732	13.4	Ht	708	11.4	En	718	11.1	Bl	633	6.0	Kd
751	7.8	Ah	751	7.8	Ah	732	12.5	Sm	711	11.5	Bl	728	10.6	L	649	6.2	Kd
752	7.9	Ah	752	7.8	Ah	735	12.7	Dw	715	11.4	En	730	11.3	Dr	678	6.3	Kd
757	7.6	Ah	753	7.7	Lj	735	12.4	Dr	717	12.1	L	735	11.4	Dr	702	6.0	Ch
758	7.5	Ah	756	7.9	Lj	738	12.5	Dr	718	11.4	Bl	736	11.2	L	702	6.0	L
760	7.9	Ah	757	7.9	Lj	738	12.5	Dw	727	12.0	L	746	11.6	L	706	6.1	Ah
760	7.8	Pt	757	7.9	Ah	743	12 5	Dr	730	11.4	En	760	12.3	L	707	6.1	Ah
762	8.0	Ah	758	8.0	Ah	747	12.3	Dr	736	11.6	L	S UMi			707	6.1	Ka
762	8.2	Jo	760	8.1	Ah	RT Lib			746	11.0	L	153378			707	6.3	Kd
769	8.0	Jo	760	7.5	Pt	*150018*			760	10.0	L	710	11.4	Lj	708	6.2	Lj
772	7.7	Jo	761	8.2	Lj	737	12.4	Wn				715	11.4	Lj	709	6.0	Be
772	7.5	Ga	762	8.1	Ah	742	12.6	Ty				718	11.3	Lj	710	6.2	Lj

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CrB	R CrB	R CrB	R Lup	Z Sco	RU Her
154428	154428	154428	*154736*	*160021*	160625a
710 6.1 An	737 6.1 Lg	761 6.1 Pt	715 10.2 Dr	760 12.2 L	718 13.6 L
710 6.1 Ch	738 6.1 Pt	761 6.0 L	730 9.8 Dr	R Her	730 13.8 L
711 6.0 An	738 6.4 Ah	762 6.1 Pt	734 9.7 Dr	160118	739 13.8 L
714 6.0 Ch	739 6.2 Pt	762 6.0 L	743 9.7 Dr	738 8.7 Pt	748 13.8 L
714 6.1 Ka	739 6.0 L	762 6.0 Jo	747 9.6 Dr	742 9.2 Sc	761 13.7 L
715 6.1 Lj	739 6.7 Sw	762 6.0 Ah	RR Lib	743 8.9 Br	R Sco
715 6.3 Kd	740 6.2 Ah	762 5.7 Wd	*155018*	760 9.2 Pt	*161122a*
716 6.0 Ah	740 6.2 Lj	762 6.0 Be	702 11.2 Dr	U Ser	686 12.2 En
716 6.0 L	741 6.0 L	764 6.2 Lj	715 10.8 Dr	160210	682 11.4 Bl
716 6.2 Kl	741 6.0 Sp	763 6.2 Pt	717 10.6 L	738 12.5 Pt	688 11.2 Ht
717 6.0 L	742 6.0 L	764 5.9 Sb	727 10.4 L	743 13.5 Br	704 12.2 En
718 6.0 L	742 6.1 Wd	764 6.3 Sw	730 10.1 Dr	760 13.0 Pt	711 12.2 Bl
718 6.1 Ah	742 6.1 Gy	765 6.0 Sb	735 9.6 Dr	X Sco	713 12.4 Nz
718 6.2 Lj	742 6.2 Ah	765 6.3 Kd	736 9.2 L	*160221a*	720 12.8 Nz
719 6.2 Lj	743 6.1 Ah	765 6.1 Pt	738 9.2 Pt	682 12.1 Bl	729[13.6 Nz
719 6.0 Be	743 6.1 Kz	765 6.2 Lg	747 8.4 Dr	711 10.9 Bl	732[11.9 Sm
719 6.1 Ah	743 6.3 Eb	766 6.1 Pt	748 8.8 L	718 11.1 Bl	S Sco
720 6.2 An	743 6.2 Lg	768 6.2 Pt	760 8.3 L	SX Her	*161122b*
721 6.1 Lj	743 6.0 L	769 6.0 Jo	760 8.6 Pt	160325	682 13.2 Bl
721 6.0 L	745 6.1 Ah	770 6.1 Lg	Z CrB	672 8.2 By	713 14.6 Nz
722 6.0 L	745 6.0 Be	771 6.2 Pt	155229	686 8.1 By	720 14.1 Nz
721 6.1 Ah	746 6.0 L	772 6.2 Pt	687 11.8 By	687 8.1 By	732[12.2 En
722 6.1 Ah	746 6.1 Pt	772 5.9 Jo	698 11.7 By	698 8.2 By	W Oph
723 6.1 Pt	747 6.0 L	773 6.2 Pt	707 11.5 By	699 8.3 By	*161607*
724 6.2 Pt	748 6.1 Pt	774 6.2 Lg	710 11.7 Ch	707 8.3 By	718 13.7 L
724 6.0 L	748 6.1 Pt	774 6.0 Wd	714 11.6 By	714 8.4 By	730 13.3 L
724 6.1 Ah	749 6.1 Kd	774 5.7 Sw	715 11.7 By	715 8.4 By	737 12.6 L
724 6.2 Wd	750 6.2 Lj	777 6.0 Sb	717 11.0 L	718 8.4 By	748 12.1 L
724 6.0 Sw	751 6.2 Pt	780 6.0 Wd	718 11.6 By	718 8.0 L	760 11.0 L
725 6.2 Pt	751 6.1 Ah	781 6.1 Sb	721 11.6 By	721 8.5 By	763 11.2 Pt
726 6.0 L	752 6.2 Ah	X CrB	723 11.6 By	723 8.5 By	V Oph
726 5.9 Wd	753 6.0 L	154536	724 11.5 Wn	723 8.0 Pt	*162112*
726 5.8 Sw	754 6.1 Lj	717 12.7 L	727 11.0 L	724 8.4 Pt	718 7.3 L
727 6.0 L	754 6.0 Sb	737 13.4 L	730 11.6 By	727 8.5 L	727 7.3 L
727 6.0 Gb	755 5.9 Sb	743 13.1 Br	736 11.4 L	729 8.2 Pt	737 7.7 L
728 6.0 L	755 6.1 Lj	748 13.3 L	743 11.7 Wn	730 8.7 By	738 7.3 Pt
728 6.1 Hs	755 6.1 Be	759 13.1 L	748 11.8 L	736 8.7 L	742 8.5 Sc
728 6.0 Sw	756 6.2 Lj	R Ser	759 12.1 L	738 8.3 Pt	748 7.8 L
728 6.0 Sp	756 6.1 Pt	154615	RZ Sco	741 8.3 Pt	761 7.9 L
729 6.2 Lj	756 6.0 L	729 11.5 B	*155823*	748 8.2 Pt	763 7.8 Pt
729 6.3 Kl	756 6.1 Sb	738 12.0 Pt	686 9.1 En	748 8.5 L	U Her
729 6.2 Pt	756 6.0 Kd	743 12.5 Br	688 9.1 Ht	751 8.7 Pt	162119
730 6.1 Lj	757 6.0 Ah	V CrB	693 9.0 En	756 8.8 Pt	738 12.5 Pt
730 6.0 L	757 6.2 Lj	154639	704 9.5 En	759 8.5 L	763 12.8 Pt
732 6.0 Be	757 6.1 Be	718 10.8 Ah	708 9.8 En	760 8.4 Pt	Y Sco
732 6.0 L	757 5.9 Wd	738 9.8 Pt	711 9.9 En	761 8.3 Pt	*162319*
733 6.2 Pt	757 6.0 L	738 10.2 B	715 10.0 En	763 8.0 Pt	718 13.2 L
733 6.0 Ka	758 6.1 Ah	760 9.1 Pt	730 11.2 En	766 8.0 Pt	731 12.5 L
734 6.0 L	758 6.0 Sb	R Lib	732 11.6 Sm	768 7.9 Pt	737 12.7 L
734 6.1 Ah	759 6.1 Sb	154715	738 11.1 Pt	772 8.0 Pt	748 11.7 L
735 6.3 Kd	759 6.1 Pt	717 11.0 L	760 10.6 Pt	773 8.0 Pt	760 11.3 L
735 6.0 Wd	759 6.0 L	718 11.7 Ah	Z Sco	W Sco	SS Her
736 6.2 Lj	760 6.0 L	731 11.9 L	*160021*	*160519*	162807
736 6.1 Be	760 6.1 Pt	737 12.2 L	682 12.1 Bl	682 11.1 Bl	718 11.4 L
736 6.0 L	760 6.1 Ah	748 12.8 L	718 12.8 L	702 12.0 Dr	727 11.5 L
737 6.0 L	760 6.0 Sb	R Lup	731 12.9 L	711 12.0 Bl	737 11.6 L
737 6.1 Lj	761 6.2 Lj	*154736*	737 12.7 L	715 13.0 Dr	738 11.6 Pt
737 5.4 Hs	761 6.0 Be	712 10.2 En	748 12.5 L	734[13.0 Dr	748 11.5 L

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
SS HER	R DRA	RR Sco	TT DRA	SV Sco	T HER
162807	163266	*165030a*	171157	*174135*	180531
759 10.4 L	738 11.8 Pt	702 10.1 Dr	714 10.1 By	682 12.5 Bl	718 9.7 Ah
763 10.0 Pt	740 11.6 Lj	708 10.6 En	715 10.1 By	714 10.0 Bl	718 10.4 L
T OPH	750 11.4 Lj	711 11.3 Bl	718 10.1 By	W PAV	719 9.8 Ah
162815	753 11.3 Lj	712 10.6 En	723 10.1 By	*174162*	724 9.9 Sw
682 10.6 Bl	756 11.1 Lj	714 10.9 Dw	730 10.1 By	681 9.6 Bl	728 11.4 L
702 9.8 Dr	757 11.0 Lj	718 11.5 Bl	Z OPH	688 9.7 Ht	737 12.0 L
705 9.8 Dr	757 10.4 Ah	732 11.1 Sm	171401	701 10.2 Bl	738 12.4 Pt
711 9.9 Bl	758 10.5 Ah	732 11.7 En	738 12.1 Pt	708 10.9 En	749 12.9 L
715 9.8 Dr	760 10.5 Ah	734 11.5 Dr	763 11.6 Pt	711 10.6 Bl	761 13.4 L
718 9.8 Bl	761 10.9 Lj	743 11.8 Dr	RS HER	718 11.1 Bl	761 13.3 Be
718 10.3 L	763 11.0 Pt	SS OPH	171723	732[12.3 Sm	763 13.2 Pt
727 10.4 L	TX DRA	165202	738 12.3 Pt	RS OPH	W DRA
734 10.8 Dr	163360	763 8.2 Pt	763 11.5 Pt	174406	180565
737 10.6 L	672 7.9 By	RV HER	S OCT	738 11.1 Pt	718 14.3 L
738 11.0 Pt	686 7.5 By	165631	*172486*	763 11.1 Pt	728[13.5 L
747 11.3 Dr	689 7.5 By	718 13.4 L	672 12.6 Bl	U ARA	739[14.1 L
748 10.8 L	698 7.3 By	731 14.0 L	676 12.2 En	*174551*	749[14.3 L
760 11.6 L	699 7.3 By	738 14.0 Pt	681 11.5 Bl	708 10.8 En	761[14.1 L
763 11.4 Pt	707 7.2 By	739 14.2 L	685 11.3 En	732 12.3 Sm	X DRA
S OPH	714 7.3 By	748 14.4 L	687 10.9 Ht	RT OPH	180666
162816	715 7.4 By	761 14.5 L	699 9.9 Ht	175111	718 14.0 L
682 10.2 Bl	718 7.4 By	RT Sco	701 9.7 Bl	718 13.6 L	728 14.0 L
702 10.6 Dr	721 7.6 By	*165636*	702 9.8 En	737 13.7 L	739[14.0 L
711 11.1 Bl	723 7.6 By	682[14.0 Bl	702 9.5 Dr	749 14.0 L	749[14.0 L
715 11.6 Dr	730 7.7 By	714[14.0 Bl	707 9.4 En	RY HER	761[14.0 L
718 11.4 Bl	RR OPH	— DRA	711 9.5 Bl	175519	TV HER
718 11.5 L	*164319*	165752	713 9.4 En	718 9.2 L	181031
731 12.0 L	713 12.0 Nz	739 13.8 L	714 9.5 Dw	728 9.2 L	718 12.5 L
734 12.5 Dr	718 11.5 L	746 13.0 L	715 9.5 Dr	737 9.5 L	728 10.6 L
737 12.7 L	720 12.2 Nz	767 13.2 L	718 9.5 Bl	738 9.4 Pt	737 10.5 L
748 14.0 L	731 11.7 L	R OPH	732 9.7 Ht	743 9.7 Br	748 10.2 L
761 14.2 L	737 12.3 L	*170215*	732 9.9 Sm	749 9.6 L	761 10.2 L
W HER	738 12.5 Pt	748 10.6 L	734 9.5 Dr	760 10.3 L	761 10.1 Be
163137	748 12.8 L	761 10.7 L	743 9.6 Dr	763 10.5 Pt	RY OPH
687 11.3 By	761 13.3 L	761 10.8 Be	RU OPH	V DRA	181103
698 9.4 By	763 13.3 Pt	763 9.7 Pt	172809	175654	738 13.5 Pt
699 9.3 By	S HER	RT HER	718 11.3 L	722 11.6 L	763 12.1 Pt
703 9.2 Ch	164715	170627	728 11.5 L	731 11.2 L	W LYR
707 8.6 By	738 10.9 Pt	718 9.4 L	737 12.0 L	739 11.3 L	181136
714 8.6 By	757 10.5 Ah	728 9.3 L	738 11.8 Pt	749 11.3 L	710 10.9 An
715 8.5 By	758 10.5 Ah	737 9.3 L	748 12.0 L	761 11.2 L	718 9.7 Ah
718 8.5 By	760 10.3 Ah	738 10.0 Pt	760 12.8 L	R PAV	719 9.5 Ah
721 8.5 By	763 10.4 Pt	748 10.1 L	763 12.5 Pt	*180363*	721 9.3 An
723 8.6 By	RS Sco	759 11.2 L	RT SER	688 6.3 Ht	724 9.2 Ah
728 8.6 Sp	*164844*	763 11.8 Pt	*173411*	702 8.0 Dr	734 9.1 Ah
730 8.6 By	682 13.0 Bl	RW Sco	718 12.2 L	708 8.5 En	737 8.9 Wd
738 8.0 Pt	688 12.0 Ht	*170833*	737 12.3 L	714 8.5 Dw	738 8.8 Ah
763 10.7 Pt	702 13.0 Dr	682[14.0 Bl	760 12.5 L	715 8.6 Dr	738 9.0 Pt
R DRA	714 12.2 Bl	714[13.0 Bl	RU Sco	715 9.0 En	740 8.8 Ah
163266	717 12.0 Dr	TT DRA	*173543*	730 9.8 Dr	741 8.8 L
708 11.9 Lj	718 12.0 Bl	171157	682 12.2 Bl	732 10.5 En	742 8.9 Ah
710 11.9 Lj	735 11.5 Dr	672 8.9 By	701 11.9 Bl	732 10.5 Sm	743 8.8 Ah
714 10.6 Hs	RR Sco	686 8.8 By	711 12.6 Bl	734 10.2 Dr	745 8.8 Ah
718 12.2 Lj	*165030a*	687 8.8 By	714 12.2 Bl	743 10.6 Dr	749 8.5 L
719 12.2 Lj	682 9.2 Bl	698 9.0 By	718 12.5 Bl	T HER	751 8.7 Ah
730 11.8 Lj	688 9.9 Ht	699 9.1 By		180531	752 8.7 Ah
736 11.6 Lj	701 10.1 Bl	707 9.9 By		706 8.9 Ah	755 8.6 Ah

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
W LYR	RS DRA	R SCT	RT LYR	RS LYR	RY SGR
181136	184074	*184205*	185737	190933a	*191033*
757 8.7 Ah	672 9.1 By	763 5.8 Pt	721 12.0 L	763 11.6 L	742 6.5 Dr
758 8.7 Ah	686 9.2 By	765 5.9 Pt	730 10.3 L	763 11.5 Pt	743 6.3 Dr
760 8.6 Ah	687 9.2 By	765 5.5 Kd	737 10.1 L	763 11.5 Be	746 6.5 L
761 8.2 L	698 9.5 By	765 5.8 Lg	749 10.3 L	RU LYR	747 6.2 Dr
762 8.5 Ah	699 9.4 By	766 5.9 Pt	763 10.7 L	190941	753 6.4 L
762 8.3 Jo	707 9.9 By	768 6.0 Pt	763 10.6 Be	721 13.3 L	757 6.2 L
763 8.1 Pt	714 10.1 By	769 5.7 Jo	R AQL	737 14.0 L	762 6.3 L
765 8.2 Jo	715 10.1 By	770 5.9 Jo	190108	U DRA	763 6.4 Pt
769 8.2 Jo	718 10.1 By	770 6.0 Gb	719 6.9 Ah	190967	766 6.2 Pt
772 7.8 Jo	723 10.1 By	770 5.8 Lg	721 7.0 Ah	721 13.1 L	768 6.3 Pt
775 8.2 Wd	730 10.1 By	771 6.0 Pt	722 7.0 Ah	739 14.0 Pt	771 6.4 Pt
780 8.2 Wd	RV LYR	772 6.0 Pt	724 6.9 Ah	740 13.7 L	772 6.5 Pt
RV SGR	184134	772 6.0 Jo	714 6.8 Ch	763 13.8 Pt	TY SGR
182133	721 13.3 L	773 5.9 Pt	735 7.4 Ah	T SGR	*191124*
682 13.1 Bl	730 13.0 L	774 6.0 Sw	738 6.5 Pt	*191017*	682 12.8 Bl
705 12.2 Dr	737 13.3 L	775 6.1 Wd	738 7.3 Ah	721 12.1 L	706 11.2 Dr
706 12.0 Dw	749 12.3 L	780 5.9 Wd	740 7.4 Ah	739 12.0 Pt	706 11.3 Dw
714 11.4 Dw	761 11.9 L	NOV AQL	742 7.5 Ah	741 11.8 L	714 11.0 Dw
714 11.7 Bl	762 11.9 Be	184300	743 7.5 Ah	762 12.4 L	714 10.7 Bl
715 10.9 Dr	763 11.6 Pt	729 11.7 Pt	745 7.7 Ah	763 12.2 Pt	715 10.5 Dr
734 9.9 Dr	774 10.5 Jo	738 11.8 Pt	751 7.7 Ah	R SGR	716 9.9 Dw
743 9.7 Dr	R SCT	751 11.7 Pt	752 7.8 Ah	*191019*	742 9.6 Dr
SV HER	*184205*	760 11.7 Pt	757 7.8 Ah	714 9.8 Ch	S SGR
182224	597 5.7 Kd	766 11.7 Pt	758 7.9 Ah	739 11.5 Pt	*191319a*
718[13.9 L	599 5.7 Kd	771 11.7 Pt	760 8.0 Ah	753 11.8 L	682 12.0 Bl
728 13.7 L	618 6.9 Kd	RX LYR	762 8.0 Ah	763 12.1 Pt	714 10.4 Bl
737[14.2 L	693 5.5 Ch	185032	763 7.2 Pt	RY SGR	714 10.2 Bl
749 13.7 L	708 5.7 Lj	714 12.0 Ch	V LYR	*191033*	721 10.0 Bl
761 13.0 L	710 5.7 Lj	721 12.5 L	190529a	682 6.0 Bl	721 10.1 L
SV DRA	716 5.7 L	729 12.5 L	721[12.3 L	702 6.3 L	739 10.9 Pt
183149	719 5.9 Lj	737 12.5 L	737[13.9 L	705 6.4 Dw	741 10.6 L
718 13.9 L	721 5.9 Lj	738 12.7 Pt	RX SGR	705 6.6 Dr	753 11.3 L
728 13.7 L	721 6.0 Ch	749 12.8 L	*190818*	713 6.8 Dr	763 12.6 Pt
740 13.4 L	722 5.9 L	762 13.8 L	739 10.6 Pt	713 6.7 Dw	SW SGR
749 13.4 L	728 5.6 L	S CRA	763 10.8 Pt	714 6.8 Dw	*191331*
761 13.0 L	729 5.9 Pt	*185437a*	RW SGR	714 6.3 Bl	682 12.3 Bl
RZ HER	730 6.0 Gb	682 11.3 Bl	*190819a*	715 6.7 Dr	714 13.5 Bl
183225	731 5.8 Lj	714 11.9 Bl	739 9.5 Pt	716 6.7 Dw	TZ CYG
718 10.3 L	735 5.5 Kd	ST SGR	763 9.4 Pt	716 6.7 L	191350
728 10.1 L	736 5.8 Lj	*185512a*	TY AQL	717 6.7 L	739 10.0 Pt
737 9.4 L	737 5.7 Lg	721[13.0 L	190907	718 6.7 L	763 10.0 Pt
743 9.4 Br	737 5.1 L	737[14.0 L	738 10.5 Pt	721 6.6 L	U LYR
747 9.8 L	738 5.8 Pt	762 13.5 L	763 10.3 Pt	722 6.5 L	191637
749 9.2 L	740 5.8 Lj	R CRA	S LYR	724 6.6 L	739 9.8 Pt
761 9.6 L	741 5.8 Pt	*185537a*	190925	726 6.5 L	763 9.9 Pt
X OPH	742 5.8 Gy	682 13.0 Bl	721[13.5 L	727 6.5 L	AF CYG
183308	747 5.1 L	714 12.1 Bl	744[13.8 Br	728 6.3 L	192745
721 8.6 L	749 5.1 Kd	T CRA	X LYR	730 6.2 L	707 7.3 By
730 8.6 L	751 5.5 Pt	*185537b*	190926	731 6.1 L	714 7.4 By
737 8.4 L	753 5.6 Lj	682 13.5 Bl	739 8.8 Pt	732 6.0 L	718 7.4 By
738 8.2 Pt	754 5.6 Lj	714[13.0 Bl	763 9.0 Pt	734 6.2 Dr	721 7.3 By
747 8.0 L	756 5.2 Pt	Z LYR	RS LYR	735 6.3 Dw	723 7.4 By
762 8.0 L	757 5.4 Lj	185634	190933a	735 6.3 Dr	724 6.9 Ah
763 8.0 Pt	759 5.3 L	721 13.2 L	721 12.7 L	736 6.2 L	730 7.4 By
769 8.4 Jo	760 5.0 Pt	731[13.8 L	730 12.0 L	738 6.3 Dw	734 7.3 Ah
772 7.7 Jo	761 5.6 Lj	738[13.6 Pt	739 12.2 Pt	739 6.4 Pt	738 7.1 Ah
774 7.4 Jo	761 5.2 Pt	739[14.0 L	740 12.0 L	741 6.3 Pt	740 7.3 Ah
	762 5.5 Pt		753 11.7 L	741 6.5 L	

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
AF CYG	RV AQL	S VUL	RR SGR	R CAP	R DEL
192745	193509	194427	*194029*	*200514*	201008
742 7.2 Ah	722 13.6 L	724 9.1 Ah	716 6.4 Dw	722 13.0 L	721 11.4 L
743 7.2 Ah	731 13.3 L	X AQL	735 6.1 Dr	741 13.3 Pt	731 11.5 L
745 7.2 Ah	740 12.8 L	194604	742 6.0 Dr	741 13.1 L	740 10.7 Ah
752 7.2 Ah	753 12.4 L	722 13.6 L	RU SGR	762[11.9 L	740 10.8 L
755 7.3 Ah	763 11.5 Pt	740[13.4 L	*195142*	766 13.6 Pt	741 10.7 Pt
757 7.2 Ah	T PAV	762[13.4 L	682 12.4 Bl	SV CYG	753 9.7 L
758 7.2 Ah	*193972*	χ CYG	714 13.6 Bl	200647	757 9.5 Ah
760 7.3 Ah	682 11.4 Bl	194632	RR AQL	742 9.4 Sc	758 9.3 Ah
762 6.9 Ah	688 11.9 Ht	707 10.2 Ah	*195202*	S AQL	760 9.3 Ah
TY CYG	701 10.5 Bl	707 9.5 Ch	722 13.1 L	200715a	762 9.0 Ah
192928	702 10.8 Dr	718 9.3 Ah	740[13.1 L	741 11.0 Pt	766 8.2 Pt
721 11.4 Ch	711 9.7 Bl	719 9.2 Ah	RS AQL	750 10.8 By	RT CAP
721 11.0 L	714 9.2 Dw	721 9.0 Ah	*195308*	766 10.4 Pt	*201121*
731 11.2 L	715 9.1 Dr	722 8.9 Ah	722 11.9 L	RW AQL	741 6.8 Pt
740 10.4 L	716 9.1 Dw	724 8.5 Ah	731 11.2 L	200715b	766 6.6 Pt
744 10.3 Br	718 8.7 Bl	734 8.0 Ah	741 10.5 L	741 9.3 Pt	SX CYG
749 10.1 L	730 7.5 Dr	738 7.5 Ah	753 10.1 L	766 9.2 Pt	201130
762 9.7 L	734 7.5 Dr	739 7.2 Pt	760 9.8 L	R TEL	721 12.9 L
763 9.5 Pt	742 7.2 Dr	740 7.5 Ah	NOV CYG	*200747*	741 13.5 Pt
RT AQL	RT CYG	742 7.4 Ah	195553	682 13.0 Bl	741 13.3 L
193311	194048	742 7.7 Sc	729[12.2 Pt	714 14.0 Bl	760 13.5 L
721 14.1 L	706 9.2 Ah	743 7.2 Ah	738[12.2 Pt	RU AQL	RT SGR
740 14.4 L	718 8.6 Ah	745 7.1 Ah	751[12.2 Pt	200812	201139
762 14.1 L	719 8.6 Ah	751 6.1 Ah	760[12.2 Pt	721 10.5 L	683 11.2 Bl
R CYG	721 8.5 Ah	752 6.1 Ah	763[12.2 Pt	731 10.4 L	706 12.2 Dr
193449	722 8.4 Ah	755 6.1 Ah	766[12.2 Pt	740 10.8 L	714 12.5 Dw
706 9.2 Ah	724 8.4 Ah	757 5.9 Ah	771[12.2 Pt	760 11.7 L	714 12.7 Bl
714 9.0 Ch	734 8.1 Ah	758 5.8 Ah	Z CYG	W CAP	715 12.8 Dr
718 8.4 Ah	738 7.8 Ah	760 5.7 Ah	195849	*200822*	716 12.3 Dw
719 8.3 Ah	739 7.2 Pt	762 5.6 Ah	740 12.7 L	682[12.8 Bl	WX CYG
721 8.1 Ah	740 7.5 Ah	765 5.9 Kd	741 12.5 Pt	714[13.0 Bl	201437b
722 8.2 Ah	742 7.7 Ah	765 5.3 Sb	762 10.1 L	741 12.0 Pt	718 8.8 L
724 8.1 Ah	743 7.5 Ah	766 5.5 Pt	766 9.2 Pt	766 11.5 Pt	724 8.8 L
734 8.0 Ah	745 7.3 Ah	769 4.8 Jo	S TEL	Z AQL	740 10.5 L
738 8.0 Ah	751 7.3 Ah	770 4.6 Jo	*195855*	*200906*	741 9.5 Pt
739 7.4 Pt	752 7.2 Ah	773 5.2 Sb	682 12.5 Bl	713 12.9 Nz	753 9.1 L
740 7.5 Ah	755 7.2 Ah	774 5.2 Sw	714 12.6 Bl	720 11.6 Nz	762 9.8 Jo
742 7.8 Ah	757 7.2 Ah	774 4.5 Jo	SY AQL	729 9.9 Nz	766 9.8 Jo
742 8.9 Wd	758 7.2 Ah	780 5.3 Wd	200212	741 10.0 Pt	766 9.4 Pt
743 7.4 Ah	760 7.2 Ah	781 5.3 Sb	721 12.9 L	766 10.1 Pt	770 10.0 Jo
745 7.5 Ah	762 7.2 Ah	S PAV	731 12.8 L	RS CYG	774 10.4 Jo
751 7.2 Ah	762 7.4 Jo	*194659*	741 12.5 Pt	200938	U CYG
752 7.3 Ah	765 7.8 Jo	705 7.1 Dr	741 13.8 L	718 7.8 L	201647
753 7.3 Ah	766 6.9 Pt	714 7.4 Dw	762 14.3 L	724 7.9 L	734 8.0 Gb
757 7.3 Ah	770 7.4 Jo	715 7.0 Dr	BU CYG	734 8.1 Gb	741 8.4 Pt
758 7.3 Ah	774 7.3 Jo	716 7.1 Dw	200250	740 8.0 L	758 8.0 Gb
760 7.3 Ah	774 7.8 Sw	735 7.3 Dr	708 12.7 Lj	741 8.2 Pt	762 7.5 Jo
762 7.4 Ah	TU CYG	742 7.2 Dr	719[12.7 Lj	742 8.7 Sc	765 8.0 Jo
762 7.3 Jo	194348	SV VUL	731[12.7 Lj	753 8.1 L	766 8.2 Pt
762 8.2 Wd	714 10.2 Ch	194727	740[12.5 Lj	758 8.4 Gb	770 8.0 Jo
763 7.0 Pt	721 11.4 Ch	724 7.4 Ah	757[12.5 Lj	762 8.0 Jo	774 8.3 Jo
766 7.2 Jo	721 10.7 L	RR SGR	S CYG	766 7.8 Jo	775 9.2 Wd
770 7.0 Jo	731 11.8 L	*194029*	200357	766 7.8 Pt	780 8.8 Wd
774 7.5 Jo	739 12.0 Pt	682 10.2 Bl	722 10.7 L	770 7.9 Jo	U MIC
774 7.6 Sw	740 12.3 L	706 7.1 Dr	740 11.6 L	774 8.3 Jo	*202240*
775 8.3 Wd	762[13.6 L	714 6.4 Dw	741 11.0 Pt	780 8.0 Wd	682[13.6 Bl
780 8.0 Wd		714 6.5 Bl	762 12.8 L		706[13.7 Dr
		715 6.2 Dr	766 12.2 Pt		714[13.6 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U MIC	V CYG	X DEL	R EQU	W CYG	RU CYG
202240	203847	205017	210812	213244	213753
717 14.0 Dr	766 11.7 Pt	716 12.9 L	741 9.2 L	595 6.1 Kd	722 8.6 Ah
735 13.3 Dr	Y AQR	724 12.4 L	756 9.0 L	597 6.0 Kd	724 8.6 Ah
742 12.7 Dr	*203905*	741 11.4 Pt	766 9.0 Pt	598 6.0 Kd	734 8.4 Ah
RW CYG	714[11.5 Ch	741 11.2 L	T CEP	609 5.8 Kd	738 8.3 Ah
202539	720 14.6 Nz	756 10.2 L	210868	610 5.9 Kd	740 8.3 Ah
742 9.2 Sc	729[14.3 Nz	766 9.6 Pt	706 10.1 Ah	621 6.0 Kd	741 8.0 Pt
RU CAP	T DEL	RR CAP	718 10.3 Ah	623 6.1 Kd	742 8.1 Ah
202622	204016	*205627*	719 10.4 Ah	624 6.0 Kd	743 8.2 Ah
720 10.6 Nz	721 9.7 L	706[13.8 Dr	728 10.2 Sw	626 6.1 Kd	745 8.1 Ah
729 11.2 Nz	741 10.5 Pt	735[13.8 Dr	734 10.5 Gb	641 6.5 Kd	751 8.0 Ah
Z DEL	753 10.8 L	R VUL	734 10.5 Ah	642 6.5 Kd	752 8.2 Ah
202817	766 12.0 Pt	205923a	738 10.5 Ah	652 6.5 Kd	755 7.9 Ah
722[13.1 L	V AQR	706 11.8 Pt	741 9.6 Pt	702 5.8 L	757 8.2 Ah
741[13.6 L	204102	741 11.0 Pt	742 10.5 Ah	716 5.7 L	758 8.2 Ah
ST CYG	722 8.9 L	757 9.2 Ah	745 10.4 Ah	722 5.6 L	760 8.2 Ah
202954	741 8.5 Pt	758 9.2 Ah	751 10.3 Ah	731 5.6 L	762 8.1 Ah
722 11.9 L	741 8.6 L	760 9.0 Ah	752 10.1 Ah	732 5.7 L	766 8.0 Pt
731 11.4 L	753 8.7 L	762 8.9 Ah	755 10.1 Ah	741 5.7 L	RV CYG
741 11.6 Pt	766 8.5 Pt	766 8.0 Pt	757 10.1 Ah	753 5.8 L	213937
741 11.2 L	W AQR	767 10.2 Jo	758 10.1 Ah	761 5.9 L	716 6.8 L
760 11.1 L	*204104*	772 10.0 Jo	760 10.1 Ah	S CEP	722 6.9 L
766 11.0 Pt	720 12.0 Nz	774 10.0 Jo	762 10.0 Ah	213678	732 6.9 L
V VUL	722 11.5 L	V CAP	766 9.0 Jo	686 9.9 By	**741 6.9 L**
203226	729 11.6 Nz	*210124*	766 9.2 Pt	687 9.9 By	741 6.6 Pt
741 8.7 Pt	741 11.0 L	682[12.7 Bl	770 8.8 Jo	689 9.8 By	756 6.8 L
766 8.7 Pt	753 9.8 L	706 11.4 Dr	774 8.7 Jo	698 9.8 By	766 6.4 Pt
R MIC	U CAP	714 10.8 Bl	774 9.4 Sw	699 9.7 By	RR PEG
203420	*204215*	735 9.7 Dr	RR AQR	705 9.7 By	214024
682 10.5 Bl	682[12.3 Bl	742 9.8 Dr	*210003*	706 9.8 Ah	741 9.6 Pt
714 9.0 Bl	714 11.6 Bl	TW CYG	722 10.9 L	707 9.6 By	766 9.5 Pt
Y DEL	722 10.5 L	210129	753[12.2 L	714 9.6 By	R GRU
203611	731 10.4 L	722 14.2 L	X PEG	718 9.6 By	*214247*
721 13.8 L	741 11.0 L	742[13.9 L	211614	718 9.6 Ah	682 10.1 Bl
741 13.6 Pt	753 11.0 L	X CAP	722 10.4 L	719 9.6 Ah	706 9.3 Dr
741 13.6 L	V DEL	*210221*	741 9.6 Pt	723 9.6 By	714 9.4 Dw
766 12.2 Pt	204318	682 10.6 Bl	741 9.7 L	724 9.5 Ah	714 9.3 Bl
S DEL	722 14.4 L	714 12.0 Bl	756 9.7 L	734 9.6 Ah	715 9.5 Dr
203816	741[13.6 L	X CEP	766 9.0 Pt	738 9.5 Ah	716 9.1 Dw
708 10.9 Lj	T AQR	210382	T CAP	740 9.5 Ah	735 9.7 Dr
710 10.9 Lj	*204405*	722 12.8 L	*211515*	741 8.6 Pt	742 10.2 Dr
718 11.0 Lj	741 10.7 Pt	742 13.2 L	682[11.8 Bl	742 9.6 Ah	V PEG
719 11.0 Lj	766 8.5 Pt	RS AQL	714[12.8 Bl	743 9.6 Ah	215605
721 11.2 Lj	RZ CYG	*210504*	724[12.8 L	745 9.6 Ah	724 10.9 L
731 11.2 Lj	204846	716 12.9 L	756 12.0 L	751 9.5 Ah	741 9.0 Pt
736 11.2 Lj	741 11.7 Pt	724 12.6 L	S MIC	752 9.6 Ah	741 9.1 L
740 11.2 Lj	766 12.2 Pt	741 13.3 L	*212030*	757 9.6 Ah	756 8.8 L
741 11.5 Pt	S IND	762 12.9 L	682 10.9 Bl	758 9.6 Ah	766 8.3 Pt
753 11.3 Lj	*204054*	Z CAP	706 13.3 Dr	760 9.6 Ah	U AQR
756 11.3 Lj	682[13.5 Bl	*210516*	714 13.6 Bl	762 9.6 Ah	*215717*
761 11.2 Lj	706 13.8 Dr	720 12.8 Nz	714 13.4 Dw	766 8.6 Pt	741 11.6 Pt
763 11.5 Lj	714 13.6 Dw	729 13.0 Nz	716 13.5 Dw	772 9.8 Jo	766 11.6 Pt
766 11.5 Pt	715 13.5 Dr	R EQU	735[13.4 Dr	774 9.7 Jo	RT PEG
V CYG	716 13.7 Dw	210812	Y CAP	RU CYG	215934
203847	717 13.4 Dr	716 10.6 L	*212814*	213753	742 11.1 L
722 12.2 L	735 13.4 Dr	720 10.1 Nz	682[12.0 Bl	706 8.9 Ah	756 10.7 L
741 12.4 Pt	742 13.1 Dr	724 9.7 L	714[12.5 Bl	718 8.6 Ah	RZ PEG
743 12.0 L		729 9.6 Nz	756[13.1 L	719 8.7 Ah	220133b
762 10.9 L		741 9.0 Pt		721 8.8 Ah	741 12.0 Pt

Variable Star Observations Received During May and June, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RZ Peg	S Gru	R Ind	R Peg	Z And	V Cet
220133b	*221948*	*222867*	230110	232848	*235209*
742 12.2 L	706 8.9 Dr	706[13.8 Dr	766 9.3 Pt	741 9.5 Pt	757 9.8 L
756 12.2 L	714 8.1 Dw	714[13.5 Bl	776 8.8 Sf	766 9.6 Pt	R Tuc
T Peg	715 8.1 Dr	735 12.8 Dr	V Cas	ST And	235265
220412	716 8.1 Dw	T Tuc	230759	233335	673[12.9 En
716 9.5 L	735 7.2 Dr	*223462*	738 11.5 Ah	741 8.8 Pt	684 13.0 En
724 9.0 L	742 7.1 Dr	706 9.3 Dr	741 10 9 Pt	766 8.5 Pt	R Cas
742 9.5 L	RV Peg	714 9.6 Dw	757 10.1 Ah	R Aqr	235350
757 9.9 L	222129	715 9.6 Dr	758 10.2 Ah	*233815*	706 10.0 Ah
Y Peg	716 12.4 L	716 10.2 Dw	760 10.0 Ah	623 9.0 Kd	718 10.4 Ah
220613	724 12.4 L	735 11.1 Dr	762 10.0 Ah	756 7.6 L	Z Peg
720[14.6 Nz	742 12.8 L	R Lac	766 9.8 Pt	Z Cas	235525
729[14.4 Nz	757 13.3 L	223841	S Peg	233956	728 9.6 L
742[13.3 L	S Lac	716 13.4 L	231508	742[13.4 L	741 8.8 Pt
RS Peg	222439	724 13.7 L	742 9.3 L	RR Cas	742 9.2 L
220714	716 12.8 L	742[14.0 L	756 8.3 L	235053	756 8.8 L
720 10.1 Nz	724 13.1 L	RW Peg	762 8.5 Ah	744 11.3 Bn	766 8.6 Pt
729 9.6 Nz	741 13.6 Pt	225914	766 8.5 Pt	751 11.3 Bn	Y Cas
741 8.9 Pt	743 13.5 L	729 11.7 Nz	V Phe	R Phe	235855
742 9.1 L	757 13.7 L	741 12.3 Pt	*232746*	*235150*	742 12.9 L
757 9.2 L	766 13.0 Pt	R Peg	706 11.7 Dr	706 10.5 Dr	757 13.2 L
766 9.3 Pt	R Ind	230110	714 12.5 Dw	716 10.2 Dw	SV And
X Aqr	*222867*	741 11.2 Pt	716 12.3 Dw	735 8.5 Dr	235939
221321	671[13.0 Bl	762 9.6 Ah	735 13.6 Dr		741 12.3 Pt
720[10.7 Nz	700[13.5 Bl	766 9.5 Sf			766 10.0 Pt
729[13.4 Nz					

Rapidly Varying Irregular Variables.

Star J.D.	Est.Obs.	J.D.	Est.Obs.	Star J.D.	Est.Obs.	J.D.	Est.Obs.
005840 RX Andromedae—				060547 SS Aurigae—			
5766.9	11.5 Pt	5768.8	11.5 Pt	5733.6	10.8 Wn	5741.3	13.9 L
010884 RU Cephei—				5734.3	11.0 L	5742.3[14.5 L	
5716.3	8.6 L	5748.3	9.1 L	5734.7	11.0 Br	5743.6[13.0 B	
5725.3	8.7 L	5761.6	9.0 L	5735.6	11.2 B	5746.3[13.3 L	
5737.3	9.1 L			5735.6	11.4 Bw	5748.3[13.3 L	
060547 SS Aurigae—				5736.3	11.3 L	5750.3[13.0 L	
5686.7[GC		5724.7[13.2 Lg		5737.3	12.0 L	5751.8[11.5 Lg	
5688.6[13.3 GC		5725.7[12.0 Pt		5737.6	12.0 Wn	5755.3[12.4 L	
5689.6[13.3 GC		5726.3[14.5 L		5737.8	12.3 Lg	5756.3[13.0 L	
5691.6[13.3 GC		5727.1	14.4 Nz	5738.6	12.3 B	5757.3[13.3 L	
5697.6[13.3 Bw		5727.3	13.8 L	5739.3	12.9 L	5760.3[12.4 L	
5698.6[13.3 GC		5727.6	12.2 B	5739.6	12.9 B	5761.7[12.6 Pt	
5699.6[14.0 GC		5728.1	10.9 Ch	5739.7	13.2 Pt	5762.3[11.5 L	
5703.7[13.3 GC		5728.3	11.0 L	5740.6	13.1 Bw	5763.4[12.4 L	
5704.1	15.2 Nz	5728.6	10.9 Sp	074922 U Geminorum—			
5705.1	15.2 Nz	5728.6	11.0 B	5686.7[14.1 GC		5716.3[13.7 L	
5707.1[13.2 Ch		5729.3	11.0 L	5688.6[13.7 GC		5717.1	13.8 Nz
5708.6[13.3 GC		5729.6	11.0 B	5689.6[13.3 GC		5718.3[13.3 L	
5709.1	14.8 Nz	5729.6	11.0 Sp	5698.6[13.7 GC		5721.3	13.7 L
5710.1[13.7 Ch		5729.8	11.0 Pt	5699.6	13.9 GC	5722.3[13.9 L	
5712.1[13.2 Ch		5730.3	10.9 L	5703.3	13.9 L	5724.7[12.0 Wn	
5715.7[12.6 Pt		5731.3	11.0 L	5704.1	14.0 Nz	5725.3[13.7 L	
5716.3[14.5 L		5731.6	11.0 B	5705.1	14.2 Nz	5726.3	14.0 L
5717.1[14.5 Nz		5731.6	11.0 GC	5708.6	13.9 GC	5727.1	13.5 Nz
5718.3[14.5 L		5731.6	10.8 Bw	5709.1	13.5 Nz	5727.3	14.0 L
5721.3[14.5 L		5732.1	10.7 Nz	5710.1[13.7 Ch		5728.1	13.8 Ch
5722.3[14.5 L		5732.3	10.9 L	5712.2[13.1 Ch		5729.7[11.7 Kz	
5723.1[11.5 Ch		5733.6	11.0 B	5714.6	13.8 B	5730.3	13.9 L

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.	Obs	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
074922 U GEMINORUM—							094512 X LEONIS—						
	5731.6	13.7	GC	5749.3	13.3	L		5726.3	12.2	L	5747.3	12.2	L
	5732.1	13.4	Nz	5750.3	13.3	L		5727.3	12.4	L	5748.3	12.3	L
	5732.3	14.0	L	5751.8	11.5	Lg		5727.3	12.3	An	5749.3	12.8	L
	5733.6	13.9	B	5753.3	11.4	L		5727.3	12.2	Be	5750.3	12.8	L
	5733.6	12.7	Wn	5755.3	13.3	L		5728.3	14.2	L	5756.4	13.5	L
	5734.7	13.8	Br	5756.3	13.0	Be		5730.4	13.9	L	5757.3	13.9	L
	5736.3	14.0	L	5757.3	12.4	L		5734.3	13.9	L	5757.4	13.0	Be
	5737.4	14.1	L	5759.3	11.7	L		5736.4	13.9	L	5759.3	13.9	L
	5737.8	13.5	Lg	5760.3	12.4	L		5737.3	14.7	L	5760.3	13.9	L
	5738.6	13.5	B	5761.3	9.9	L		5739.3	14.2	L	5761.3	13.9	L
	5739.3	13.7	L	5761.3	9.6	Be		5741.3	14.7	L	5762.4	12.3	L
	5741.3	14.0	L	5761.7	9.2	Pt		5742.3	14.7	L	5762.4	12.0	Be
	5742.3	13.7	L	5762.3	8.8	Be		5746.3	14.7	L	5763.3	13.9	L
	5743.8	13.2	Lg	5762.3	8.8	L	202946 SZ CYGNI—						
	5746.3	13.3	L	5763.3	8.6	L		5729.8	9.0	Pt	5761.7	9.2	Pt
	5747.3	13.3	L	5763.3	8.7	Be		5738.7	9.0	Pt	5763.7	9.0	Pt
	5748.3	13.3	L					5739.7	9.2	Pt	5766.8	9.0	Pt
081473 Z CAMELOPARDALIS—								5741.7	9.5	Pt	5768.8	8.9	Pt
	5703.3	11.2	L	5737.6	12.2	L		5748.8	9.0	Pt	5771.8	9.5	Pt
	5705.4	11.4	An	5739.3	11.9	L		5751.8	9.0	Pt	5772.8	9.5	Pt
	5705.4	11.4	Be	5741.3	12.4	L		5756.8	9.5	Pt	5773.7	9.5	Pt
	5710.4	11.6	An	5741.5	12.8	L		5760.7	9.5	Pt			
	5711.4	11.5	An	5741.7	12.7	Br	213843 SS CYGNI—						
	5716.3	11.5	L	5742.3	12.4	L		5702.7	11.3	L	5737.1	8.2	Lg
	5717.6	11.3	L	5742.6	12.3	L		5708.6	12.0	Lj	5737.6	8.5	L
	5718.3	11.8	L	5743.5	12.8	L		5710.5	12.0	Lj	5738.4	8.4	Ah
	5720.4	12.3	An	5743.7	12.7	Br		5710.6	12.0	Lj	5738.7	8.8	Pt
	5720.4	12.4	Be	5746.3	12.9	L		5716.6	11.6	L	5739.6	8.6	L
	5721.3	12.2	L	5747.3	12.7	L		5717.6	11.6	L	5740.4	8.7	Kl
	5721.6	12.6	L	5748.3	12.3	L		5718.4	11.7	Ah	5740.5	8.5	Ah
	5722.3	12.6	L	5748.6	12.5	L		5718.6	11.7	L	5740.5	8.3	L
	5722.6	13.1	L	5749.3	12.5	L		5718.6	11.9	Lj	5741.6	8.7	L
	5724.6	13.1	L	5749.6	12.4	L		5719.5	11.9	Lj	5741.7	9.2	Pt
	5725.3	13.0	L	5750.3	11.2	L		5719.5	11.8	Ah	5742.4	9.0	Ah
	5726.3	12.9	L	5750.6	10.8	L		5719.6	11.9	Lj	5742.4	9.0	Kl
	5727.3	13.1	L	5753.4	11.0	L		5721.4	12.0	Ch	5742.5	8.9	L
	5727.4	12.3	An	5755.3	11.4	L		5721.6	12.0	Lj	5743.4	9.5	Ah
	5727.4	12.6	An	5755.3	11.6	Be		5721.6	12.0	L	5743.5	8.7	Lj
	5727.4	12.4	Be	5756.4	11.5	Be		5722.5	12.0	L	5743.5	9.2	L
	5727.6	13.1	L	5756.4	11.5	L		5723.4	12.0	Ch	5743.9	9.7	Br
	5728.3	12.9	L	5757.3	11.6	L		5724.6	11.9	L	5745.4	10.2	Ah
	5728.6	13.0	L	5757.3	11.5	Be		5724.8	12.0	Wn	5746.6	10.1	L
	5729.3	12.9	L	5759.3	11.5	Be		5726.6	11.7	L	5747.6	10.4	L
	5730.3	12.2	L	5759.3	11.5	L		5727.6	11.0	L	5748.6	10.8	L
	5730.6	11.3	L	5760.3	11.5	L		5728.6	9.1	L	5749.6	10.8	L
	5731.3	11.0	L	5760.3	11.5	Be		5729.4	9.5	Kl	5750.6	11.1	L
	5732.3	11.0	L	5761.3	11.5	Be		5729.5	9.0	L	5751.8	11.7	Pt
	5732.6	10.9	L	5761.3	11.4	L		5729.8	9.3	Pt	5753.4	11.9	Lj
	5734.3	11.3	L	5762.4	11.2	L		5730.6	8.9	L	5753.6	12.0	Lj
	5734.7	11.3	Br	5762.4	11.3	Be		5731.6	8.7	L	5753.6	11.5	L
	5736.3	11.5	L	5763.4	11.4	Be		5731.6	8.8	Lj	5754.5	12.0	Lj
	5736.6	11.8	L	5763.4	11.3	L		5732.6	8.5	L	5756.6	12.0	Lj
	5737.3	11.7	L					5734.5	8.3	Ah	5756.6	11.6	L
094512 X LEONIS—								5734.6	8.4	L	5757.4	12.0	Lj
	5703.3	14.7	L	5718.3	13.9	L		5735.4	8.3	Kl	5757.6	11.8	L
	5705.4	13.5	An	5718.5	13.9	L		5735.5	8.0	Ah	5758.4	12.0	Ah
	5705.4	13.2	Be	5721.3	12.1	L		5736.4	8.4	Kl	5759.6	11.5	L
	5710.4	13.5	An	5722.3	12.0	L		5736.5	8.5	Lj	5760.6	11.4	L
	5716.3	14.7	L	5725.3	12.1	L		5736.6	8.5	L	5760.4	11.8	Ah

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.Obs	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—					213843 SS CYGNI—				
	5760.7	11.7 Pt	5762.4	12.0 Ah		5766.8	11.7 Pt	5772.7	11.2 Jo
	5761.4	12.0 Lj	5762.6	11.6 L		5768.8	11.7 Pt	5772.8	11.7 Pt
	5761.5	11.9 Lj	5763.5	11.9 Lj		5770.7	11.7 Jo	5773.7	11.7 Pt
	5761.6	11.7 L	5763.7	11.6 Pt		5771.8	11.7 Pt	5774.7	11.5 Jo
	5761.7	11.7 Pt	5765.7	11.8 Jo					

SUMMARY OF OBSERVATIONS, MAY-JUNE, 1929.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	47	430	Houghton	Ht	44	101
Allen	Al	8	8	Jones	Jo	24	69
Ancarani	An	19	48	Kanamori	Ka	2	13
Baldwin	Bl	99	349	Kanda	Kd	12	81
Benini	Be	38	78	Kohl	Kl	4	15
Beyer	By	18	144	Kurtz	Kz	15	15
Bigelow	Bw	11	25	Lacchini	L	186	895
Boutell	BL	6	68	Leiner	Lj	12	151
Bouton	B	73	94	Logan	Lg	40	66
Brocchi	Br	23	25	Nizamiah Ob.	Nz	25	67
Brown	Bn	3	7	Peltier	Pt	168	385
Chandra	Ch	53	75	Schoenfeld	Sc	10	10
Dartayet	Dr	68	300	Smith,F.M.	Sf	15	29
Dawson	Dw	55	120	Smith,W.H.	Sm	30	31
Ebert	Eb	15	15	Soberanes	Sb	1	3
Ensor	En	59	247	Swanson	Sw	15	27
Gaebler	Gb	9	13	Spears	Sp	9	11
Georgetown Coll. Obs.	GC	13	55	Taylor	Ty	16	46
				Webb	Wd	14	36
Gregory	Gy	3	3	Wilson	Wn	24	39
Grossman	Ga	1	1				
Haas	Hs	6	10	Totals	41	432	4188

quietude, was observed at maximum at the end of May. SU Tauri is now near the Sun, but early morning observers should be on the watch to catch it just as soon as it emerges from the Sun's rays within a few weeks. There have been three well-observed minima during the past 200 days, and we must be certain that none passes unobserved. S Apodis is struggling hard to recover its normal maximum brightness, having been fainter than the fourteenth magnitude for nearly a year.

LEON CAMPBELL, Recording Secretary.

July 10, 1929.

Co-operative Observing of Cepheid Variables.

The value of coöperative work on variable stars of long period and on irregular variables of the R Coronae and SS Cygni type has been demonstrated by the activities of the several variable star associations during the past two or three decades. Th need of extending coöperative plans to the problems of Cepheid variables is becoming urgent, since irregularities such as are exhibited by RR Lyrae, RR Geminorum, and others, are of especial physical significance, and can only be studied from extensive and continuous series of observations preferably made at stations widely distributed in longitude.

The Committee on Variable Stars of the International Astronomical Union decided at its last meeting to carry forward a coöperative program involving both

visual and photographic observations. A sub-committee was appointed, with Professor J. Mascart of the Lyons Observatory as chairman and the Harvard Observatory acting as secretary. It is proposed to concentrate for one or two years on a few selected fields containing a considerable number of Cepheid variables of widely different periods. Through earlier efforts at a few observatories, especially the Dominion Observatory at Ottawa, a definite start has been made on magnitude sequences and selection of fields, and several valuable series of photographs have been obtained at Babelsberg, Moscow, Ottawa, Tashkent, Tokyo, and Zi-Ka-Wai observatories.

Professor Mascart has prepared a detailed report, setting forth the need of coöperative observing on Cepheid variables, and the whole of this report is printed in the *Bulletin de l'Observatoire de Lyon* for May, 1929, and will probably appear later in English in the *Journal of the Royal Astronomical Society of Canada.*

Already assurance has been given that *visual* or photometric observing stations are to be established at Vienna, Potsdam, Beirut, Lyons, Copenhagen, Leningrad, Moscow, and Tokyo. *Photographic* stations are planned for Harvard, Ottawa, Coimbra, Lyons, Leiden, Neubabelsberg, Moscow, Tashkent, and Tokyo. It is hoped that additional stations may be established in western United States, Honolulu, and China.

In brief, the observers are asked to follow, as continuously as they can throughout a given observing season, as many of the selected Cepheid variables as they are able. Lists of the fields chosen by the sub-committee, some marked as preferential in case the whole program is too extensive, are given herewith. Inquiries and reports of the progress of the work will be welcomed by the Harvard Observatory. Suggestion will gladly be made as to the procedure preferred, in order to make the work as homogeneous as possible.

Because of the variety of instrument that will be involved in this work, it seems best to leave to the individual observer the details of exposure times, kind of plates, frequency of observations, and length of runs suitable for his equipment. But in general the sub-committee recommends a standard type of fast photographic plate; exposures long enough to show stars at least one magnitude fainter than the faintest variable under study; alternating long and short exposures, if several variables of widely different magnitudes are in the field; a standardized development of the plates; full records of conditions and procedures; and observations throughout a considerable range in hour angle in order that sufficient overlapping with other stations is assured. Since comparatively few of the variable stars change rapidly, it may, in general, be practicable to carry along observations on two or more fields during the same night.

It is suggested that observers energetically follow the fields of the accompanying list during the months indicated in the last column to insure best coördination This requirement should not preclude observations on any fields desired at other times. The names and other details on all the variables of these fields will be given in Professor Mascart's report, or will be sent before publication upon request to the Harvard Observatory.

It is hoped that the observer or his associates may undertake the prompt measurement of the photographs and communicate the results to the Harvard Observatory; though it is recognized that in many cases individual discussion of the material and separate publication are desirable.

It is expected that within two years a sufficient accumulation of reduced measures on the selected variable stars can be transmitted through the Harvard

Observatory to the sub-committee in order that a report with recommendations can be prepared for the meeting of the International Astronomical Union in 1932.

LIST OF REGIONS FOR COÖPERATIVE OBSERVING OF CEPHEIDS.

Region	R.A. (1855) h m	Dec. °	Number of Variables	Range in Period d d	Range in Magnitude	Months of Observing
1	0 44	+60	8	0.8 to 98.5	9.0<12.0	Sept.-Oct.
2*	1 56	+57	8	4.6 116.	7.4 11.6	Oct.-Nov.
3	5 0	+41	6	3.9 72.	7.2 11.4	Nov.-Dec.
4*	6 4	+25	7	0.4 89.3	5.0<12.5	Dec.-Jan.
5	10 12	+26	4	0.4 87.5	9.1 12.5	Feb.-March
6	12 16	+31	5	0.3 0.6	10.5 12.2	March-April
7*	14 24	+36	7	0.3 138.	7.5 12.5	April-May
8	18 36	− 9	8	0.5 23.	6.4 12.9	June-July
9*	19 44	+29	7	3.8 135.	6.7 13.	July-Aug.
10	22 44	+59	7	0.3 10.9	3.6 9.9	Aug.-Sept.

The asterisks indicate fields of primary importance.
Centers of fields are for Epoch of 1855.
Number of Variables is for a region covering 10 square degrees.
Range in Period is from the smallest to the largest in the region cited.
Range in Magnitude is from the brightest maximum to the faintest minimum.
Months for Observing are those during which the region will be best placed for observation at midnight. Exposures should be confined as much as possible to hour angles not exceeding three hours east or west.

TENTATIVE PLAN OF OBSERVING WITH THE BACHE 8-INCH AND ROSS 3-INCH AT HARVARD.

Region 9*

Position $19^h\,44^m$ $+29°$ (1855)

To be photographed each clear night during the months of July and August.
Bache plates, slightly out of focus, with 5 and 20 minute exposures on alternate plates.
Ross plates, slightly out of focus, 10 and 30 minute exposures on alternate plates.
Cramer Hi Speed Plates developed with Rodinal.
With no periods in this region under a day, multiple exposures on same plate are not needed, nor will more than two or three plates be required on any one night. Work will probably be carried on contemporaneously on regions 8 and 10 with appropriate modifications of exposure times and plate frequencies.

OCCULTATIONS.

Prediction of Occultations for Amherst, Mass., and Vicinity.

(Disappearances Only)

Date 1929	Star	Mag.	G.C.T. h m	*a* m	*b* m	P °
Sept. 10	19 Scorpii	4.9	0 38	−1.4	−0.5	59
14	ω Sagittarii	4.8	2 25	−0.9	+1.0	26
14	A Sagittarii	4.9	4 9	−0.9	−0.5	63
16	143 B. Capricorni	6.1	5 39	−1.0	−0.4	64
18	290 B. Aquarii	6.3	2 0	−2.1	+0.8	104
18	ψ^3 Aquarii	5.2	5 40	−1.2	+0.7	45
21	o Piscium	4.5	8 33	−1.0	+1.0	32
Oct. 20	53 Arietis	6.0	4 47	−0.5	+2.9	18
21	A Tauri	4.5	3 55	−1.1	+1.4	80
21	39 Tauri	6.1	4 18	−2.0	+0.2	113
22	k Tauri	5.6	1 6	+1.5	+3.1	3
24	134 B. Geminorum	6.5	4 56	−0.2	+1.6	76
25	28 Cancri	6.1	9 10	−1.7	−1.2	108

The G.C.T. of the occultation at some other station within 300 miles of Amherst may easily be found from the coefficients a and b and the formula

$$\text{G.C.T.} = \text{Predicted G.C.T.} + a\Delta\lambda + b\Delta\phi,$$

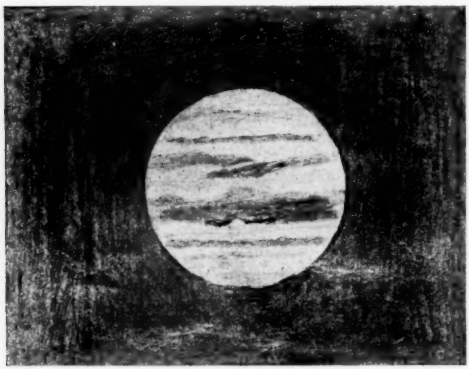
where $\Delta\lambda$ is equal to the longitude of the place (to tenths of a degree) minus the longitude of Amherst (72.5 degrees) and $\Delta\phi$ is equal to the latitude of the place (likewise to tenths of a degree) minus the latitude of Amherst (42.4 degrees). For distances up to 300 miles the error of this formula will rarely exceed 2′.

ROY MARSHALL.

910 E. Huron Street, Ann Arbor, Michigan.

NOTES FROM AMATEURS.

Observations of Jupiter.—During the past five months I have frequently observed on the planet Jupiter a very distinctive marking, which seems to be quite permanent. As I have not seen mention of it anywhere, I thought that readers of POPULAR ASTRONOMY might be interested; and thus it could be widely observed for peculiarities in rotation period.



JUPITER WITH MARKING, AT 8:05 P.M. E.S.T., FEBRUARY 12, 1929.

The marking is situated at about latitude 20° north, being on the northern border of the main northern belt, which is now so conspicuous. The central part consists of an indentation in the northern side of the belt about 3″ wide. On each side of the indentation and running along the northern border of the belt is a very dark line-like marking about 4″ long by 2″ wide. These two line-like markings and the indentation together make a marking about 12″ long. The whole thing somewhat resembles the two lines by which astronomers often mark a star on a photographic plate.

The marking has remained very constant in appearance since I first noticed it on October 26, 1928. It has, if anything, grown more conspicuous, and the region around it is just now (March 20) very much disturbed. At all times when present, it has been easily visible in the 6-inch refractor with a power of 120.

When carefully looked for and with favorable conditions, it should be visible in a 2-inch with power 70.

I give below my observations of the meridian crossings of the spot. The last column gives the time corrected for the changing apparent longitude of Jupiter, taking October 26, 1928, as the starting point. I did not observe the actual meridian crossing of the spot, but deduced it from measurement of my drawings, remembering that the apparent distance of the marking from the meridian is proportional to the sine of the angle at the planet's center between the spot and the meridian. The correction given by the last column is proportional to the planet's change of apparent longitude. A few of the rotation periods calculated from the observations are also given. In all cases the center of the spot is used for the time observation, and the time used is Eastern Standard.

MERIDIAN CROSSINGS OF SPOT.

Observation	J.D.		Apparent	Sidereal
1.	2425546	at	11:20 P.M.	11:20 P.M.
2.	561	"	8:45 P.M.	8:50 P.M.
3.	650	"	6:20 P.M.	6:25 P.M.
4.	655	"	7:55 P.M.	7:55 P.M.
5.	660	"	7:05 P.M.	7:05 P.M.
6.	688	"	8:30 P.M.	8:20 P.M.
7.	691	"	7:25 P.M.	7:15 P.M.

ROTATION PERIODS.

Calculated Between Observations	Period h m s	Elapsed Time h	Number of Rotations
(1) and (7)	9 55 52.3	3475.92	350
(1) and (6)	9 55 37.7	3405.0	343
(1) and (5)	9 56 0	2731.7	275
(1) and (4)	9 56 1	2612.6	263
(1) and (3)	9 55 29	2491.1	251
(1) and (2)	9 55 50	357.5	36
(2) and (7)	9 56 2.8	3118.4	314
(2) and (6)	9 55 35.4	3037.5	306
(2) and (5)	9 56 3	2374.25	239
(5) and (7)	9 55 20	744.16	75

A glance at these calculated periods suggests at once that either the observations were very inaccurate, or else the spot is jumping around considerably. So far as I know, the computation is free from error. The average of these periods is $9^h\,55^m\,47^s$, which is only a little larger than the usual assumed value of the period. However, individual deviations run as high as 25^s. These cannot, I am sure, be due entirely to observational errors, although the fact that they occur in both directions suggests such an explanation. Take the period $9^h\,56^m\,3^s$, computed from 314 rotations. The deviation from the average is 16^s and on the assumption that this is due to error, the error in each of the original observations must have been ± 83 minutes. This is obviously out of the question. I am certain that the error on an individual observation is less than $\pm 10^m$ and probably no greater than $\pm 5^m$.

Such apparently anomalous rotation periods need confirmation. If the spot is moving, it is jumping back and forth and, in general, getting nowhere. A few observers with telescopes over 2-inches could, by pooling observations, soon settle the question. A few minutes time is sufficient to identify the spot and draw it in position, and the observing program could be so arranged that Jupiter need only be observed when the spot is visible.

The following formulae are convenient in reducing the observations:
The rotation period p is, of course, given in hours by

$$p = \frac{(t_2 - t_1) + 24(T_2 - T_1)}{n}$$

where t_2 and t_1 are the times of the sidereal meridian crossing and T_2 and T_1 are the Julian dates. The number of rotations n is found by *assuming* the period at 9^h93.

The time of apparent meridian crossing t_a is given by

$$t_a = m \pm \frac{9.93 \sin^{-1}(d/l)}{360}$$

where m is the standard time at which the drawing or measure was made; d the apparent distance of the spot from the meridian and l is one-half the length of the chord formed by the parallel of latitude in which the spot lies. The upper and lower signs are to be used respectively when the spot is east or west of the meridian.

The time of sidereal meridian crossing t_s is given by

$$t_s = t_a + \frac{9.93 (\lambda_1 - \lambda_2)}{360}$$

where λ_1 and λ_2 are the apparent longitudes of the planet at the times of first and second observations, respectively.

RAYMOND H. WILSON, JR.

April 10, 1929.

A Geometrical Method for Constructing the Angles of a Sun Dial.

In POPULAR ASTRONOMY for April, 1928, page 211, there appeared an interesting account of the construction of a sun dial. The angles of the dial were fixed by geometry. The method, however, is somewhat tedious and complicated, and the following is suggested as simpler and more expeditious.

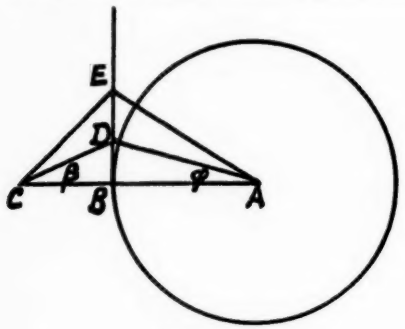


FIGURE 1.

Let A be the center of a circle with any convenient radius AB. From B lay off the hour angles BAD, DAE, etc., at the rate of 15° to the hour. In AB extended lay off BC equal to $AB \sin \lambda$ (where λ is the latitude). The length of BC can be obtained either by calculation, or by construction. Then C will be the center of the sun dial, and the angles $BCD = \beta$, DCE, etc., will be the angles on

the sun dial corresponding to the hour angles $BAD = \phi$, DAE, etc. For

$$\tan\beta = BD/BC, \text{ and } \tan\phi = BD/AB, \text{ therefore } \tan\beta/\tan\phi = AB/BC.$$

But $BC = AB \sin\lambda$, by construction.

Therefore $\tan\beta/\tan\phi = AB/(AB \sin\lambda) = \operatorname{cosec}\lambda$.

The above is the equation of the sun dial as given in the article mentioned. In the above, the equation of the sun dial has been taken as

$$\tan\beta = \operatorname{cosec}\lambda \tan\phi,$$

in order to conform to the article referred to at the beginning. But the better and more usual form of that equation is

$$\tan\beta = \sin\lambda \tan\phi.$$

It is arrived at by measuring the hour angles from the meridian instead of the prime vertical.*

L. M. BERKELEY.

New York City, June, 1928.

GENERAL NOTES.

Dr. Jan Schilt, research assistant at the Yale Observatory, has been promoted to an assistant professorship. (*Science*, May 31, 1929.)

Robert Stewart Hyer, professor of physics and president emeritus in Southern Methodist University, well-known physicist and educator, died of heart failure May 29 at Dallas, Texas.

Dr. Clifford C. Crump has accepted an appointment as Professor of Astronomy at the University of Minnesota. He will begin his duties there at the beginning of the academic year.

Dr. W. H. Steavenson, of London, delivered an illustrated lecture before the Amateur Astronomers Association at the American Museum of Natural History in New York City on June 5, his subject being "William Herschel, The Father of Amateur Astronomy."

Dr. William Wallace Campbell, since 1901 director of the Lick Observatory and since 1923 president of the University of California, has announced his intention of resigning from the presidency of the university at the end of the next academic year. (*Science*, May 24, 1929.)

Dr. Harlan True Stetson, of the Harvard Astronomical Laboratory and Assistant Professor of Astronomy in Harvard University, has been appointed Director of the new Perkins Observatory, Professor of Astronomy, and Head of the Department, in Ohio Wesleyan University, at Delaware, Ohio.

Dr. Ralph E. Wilson of the Dudley Observatory has recently been appointed as an associate editor of *The Astronomical Journal*. Dr. Wilson has been a member of the staff of the Dudley Observatory since 1918, and since 1923 has had unofficial connection with the publication of *The Astronomical Journal*.

*See Ball, *Spher. Astron.*, p. 395; Godfray, *Astron.*, p. 182; *Encyc. Brit.* (11th ed.), vol. 8, p. 151.

Worcester Reed Warner, senior member of the Warner and Swasey Company, died in Eisenach, Germany, on June 25. Mr. and Mrs. Warner went to Europe early in May intending to spend the summer there. Mr. Warner suffered a heart attack on June 23, after which he did not regain consciousness.

An adequate account of Mr. Warner's contributions toward the development of the science of astronomy will be given in the pages of this magazine in the near future.

Professor William Hammond Wright, Astronomer of the Lick Observatory, received well-merited recognition in the form of an honorary degree of Doctor of Science, at the annual Commencement of Northwestern University on June 17, 1929. Professor Wright was presented for the degree by an early member of the Lick Observatory staff, Professor Henry Crew, with this characterization:

"Doctor of Science—William Hammond Wright"

"Astronomer eminent for his contributions to our knowledge of those two mysteries of the heavens—new stars and nebulae: designer of instruments, master of stellar spectroscopy and of the physics of planetary atmospheres: untiring observer and accurate interpreter."

A Tribute to the Memory of Garrett P. Serviss. — The passing of Garrett P. Serviss on May 24 in a hospital at Englewood, New Jersey, removes from earthly activities one of the most brilliant contributors to the already voluminous literature of popular astronomy.

In a letter to the writer under date of May 5 he stated that he "had been suffering the tortures of the damned from an attack of otitis media" but was improving and anticipating sailing for France where he usually spent several months annually. However meningitis developed from mastoid involvement and the patient soon was beyond all professional skill.

Mr. Serviss was a unique figure in astronomical circles by reason of his outstanding ability to present the various subjects in a style which was compellingly fascinating throughout. One had but to begin to read any of his writings and the beauty of his diction was so irresistible that it was virtually impossible to lay it aside before completing its perusal.

His newspaper articles were eagerly read by uncounted thousands of amateurs who anxiously awaited each succeeding one with the most pleasurable anticipation.

He had a Byrne objective of five and one-half inches in the telescope with which he made many observations. It may not be generally known that Mr. Serviss was one of the first to detect the "Great Red Spot" on Jupiter in 1878 and was also one of the earliest observers of Nova Persei in 1901.

Now that he has entered the Great Unknown, let us trust that he is glimpsing in even greater degree the glories of the celestial realms about which he loved to write. He performed a great task in elevating the thoughts of multitudes to the heights of sublimity, and humanity is better for his having lived.

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Mathematical Association of America. — The thirteenth summer meeting of the Mathematical Association of America will be held, by invitation, at the University of Colorado, Boulder, Colorado, on Monday and Tuesday,

August 26-27, 1929, in conjunction with the summer meeting and the colloquium of the American Mathematical Society. The sessions of the Association will open at 2:00 P.M. Monday and 9:00 A.M. Tuesday.

On Tuesday evening those attending the meetings will go to University Camp as guests of the University. Wednesday will be devoted to an all-day excursion into the elevated and scenic Estes Park and Rocky Mountain region. Other short trips and typical western outings are being planned. These meetings will offer an unusual opportunity to combine mathematical activities with a pleasant outing.

The American Astronomical Society Meeting.—The forty-second meeting of the Society is to be held at the Dominion Observatory, Ottawa, on the invitation of the Minister of the Interior and the Director of the Observatory. The Council will hold its first meeting on the evening of Monday, August 26, and the Society will start on the program of papers the next morning, probably at 9:00 o'clock, as usual. An informal reception at the Observatory is planned for Tuesday evening; a motor drive for Wednesday afternoon; a lecture under the joint auspices of the local section of the Royal Astronomical Society of Canada and the American Astronomical Society on Wednesday evening; and a farewell dinner on Thursday evening. The Observatory will be open for inspection at all times and particularly during and after the reception on Tuesday evening. The Society will hold a business meeting on the proposed revision of the Constitution and By-Laws and for the election of Council members.

The Committee on Astronautics of the Société Astronomique de France awarded its first annual international prize to Hermann Oberth, a German teaching at the College of Medinsch, Roumania. The presentation ceremonies were held at the Sorbonne on June 6. Walter Hohmann, a German engineer, and Noel Deisch, an American biologist, were given honorable mention. Oberth's paper was deemed of such unusual merit that the original prize of 5,000 francs was raised to 10,000 francs by the founders, Mr. Robert Esnault-Pelterie, a French aeronautic engineer, and Mr. Andre Hirsch, a French banker interested in astronomy.

Twenty-five papers were submitted, these coming from Austria, France, Germany, Italy, and the United States. Oberth, whose work "Die Rakete zu den Planetenräumen" (München & Berlin, 1923) is well known, developed in detail two forms of rocket apparatus powered respectively by hydrogen and oxygen and by alcohol and oxygen. Hohmann, who had also published a work "Die Erreichbarkeit der Himmelskörper" (München & Berlin, 1925) considered in his paper methods of effecting a landing on a planet, more especially the earth. Deisch confined himself to a study of the biological factors active aboard a vessel voyaging through interplanetary space.

Zodiacal Light Notes.

A letter from Miss Rebecca Jones, assistant at Lick Observatory, says that on otherwise favorable nights persistent fog has made Zodiacal Light observations almost impossible during the earlier months of this year. Such conditions have been quite general. On May 5 and 10 and June 3, 4, and 6 the writer observed the Light without any noteworthy incident except that on May 10 the apex of the cone did not appear to extend so far as on May 5 but *by turning towards the east and then tracing the ecliptic westward* the apex of the cone was seen easily near Praesepe. This was at 8:45 P.M. At 9:20 the narrower Zodiacal

Light band was seen distinctly to a point a few degrees east of Regulus, the darker sky at this time bringing out the fainter light plainly. On June 4 the Gegenschein was glimpsed as an elongated, elliptical patch, with an estimated major diameter of 15° extending east beyond the head of Scorpio. On June 6 at 8:50 P.M. the sky between Ursa Major and Gemini was still illuminated by twilight. A steady watch was kept during which the twilight was seen to fade away by narrowing down to the plane of the ecliptic until at 9:20 the Zodiacal Light stood out clearly through Cancer and Leo Major.

Fluctuations.—A correspondent asks if pulsations or fluctuations in the Zodiacal Light have been reported. Yes, by more than one observer, usually in the tropics. On January 29, 1854, in Lat. 26° N. and Long. 127° E., Chaplain George Jones, U.S.N., observed pulsations. Naval officers who were observing the Zodiacal Light with him said: "Now it seems to be dying away." "Now it is brightening again." This condition is most marked in the stronger light which prevails in the tropics; the more oblique reflection angle of the diffuse light does not bring it out so noticeably.

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A Correction. — I should like to call attention to a slight error existing in my paper "A Graphic Interpretation of the Occultation Reduction Formulae" which appeared in the March issue of POPULAR ASTRONOMY. It was there stated that the computing blank was arranged by Professor Brown. Recently, however, I have been informed to the contrary. Professor Brown turned the Innes formulae over to Mr. J. E. G. Yalden of Leonia, New Jersey, who made up the blank form for the reduction and so should receive the credit.

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BOOK REVIEW.

Handbuch der Astrophysik, Band IV, Das Sonnensystem, 500 pp., 221 illustrations. Julius Springer, Berlin, 1929. Price 78.80 marks bound.

The second volume of this great reference work has just been received. It deals with the solar system. The sections and authors are: Strahlung und Temperatur der Sonne by Dr. W. E. Bernheimer, Solar Physics by Prof. G. Abetti, Eclipses of the Sun by Prof. S. A. Mitchell, Die physiche Beschaffenheit des Planetensystems by Prof. K. Graff, Kometen und Meteors by Prof. A. Kopff. Each section is complete in itself yet there is practically no overlapping. The various authors give a clear exposition of their respective subjects. One matter that stands out is Prof. Mitchell's historical survey of solar eclipses in which he shows how our knowledge of solar eclipse problems advanced step by step as one eclipse followed another. The many references to original papers, the tables and excellent illustrations make this volume of great value to all who desire to keep in touch with the latest thought in the astrophysical aspects of our solar system. No doubt many will purchase the entire work of six volumes as they are issued, but the volumes can also be purchased singly. We can recommend highly this volume on the solar system.

E. A. F.